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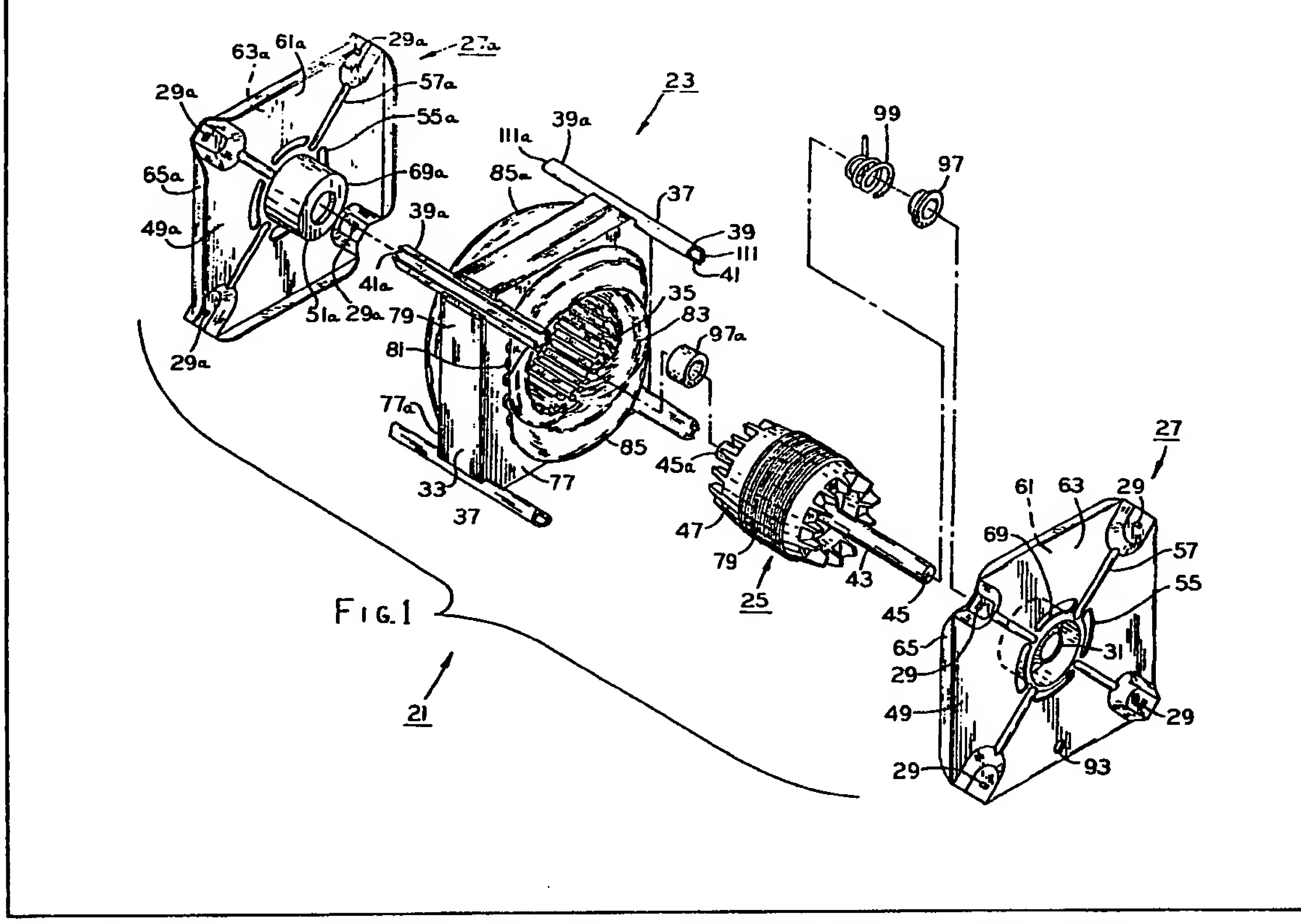
(71) Applicants
General Electric Company,
(USA-New York),
1 River Road,
Schenectady,
12305 New York,
United States of America.

(72) Inventors
Robert Walling White,
Frank Richard Kuzan.

(74) Agent and/or Address for Service
Brookes & Martin,
High Holborn House,
52/54 High Holborn,
London WC1V 6SE.

(54) Dynamoelectric machines

(57) A set of beams 37 of a stationary assembly 23 for a dynamoelectric machine are secured to a pair of opposite end frames 27, 27*a*, the opposite ends of each beam having oppositely extending tabs 41, 41a which extend through respective apertures 29, 29*a* in the end frames, the sidewalls of the apertures being spaced from the tabs. During assembly, the tabs are located at least in part within the respective apertures in the end frames with the tabs spaced from the sidewalls, and at least those parts of the end frames adjacent the respective apertures are welded to at least a part of the respective tab.



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The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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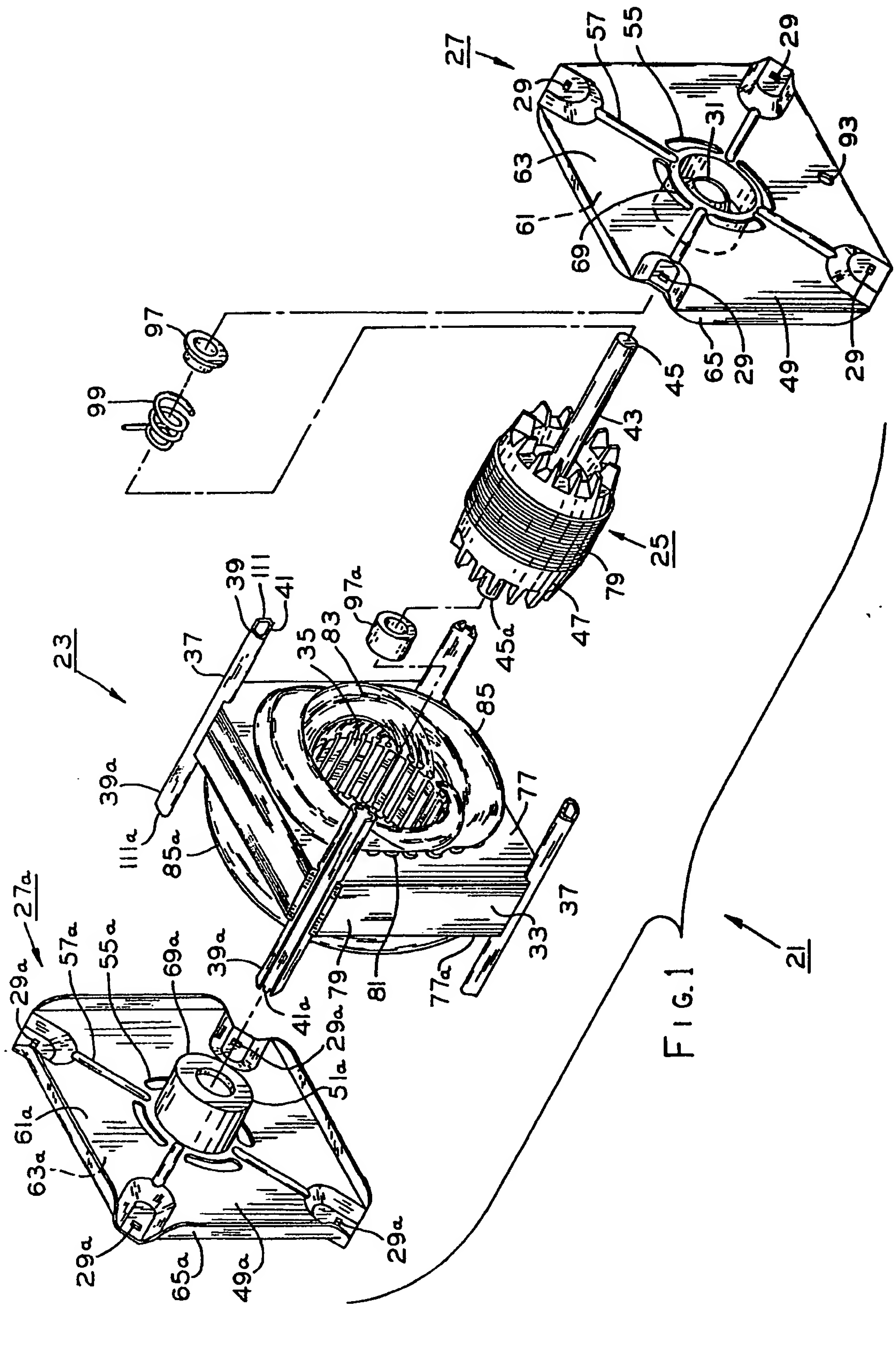


FIG. 1

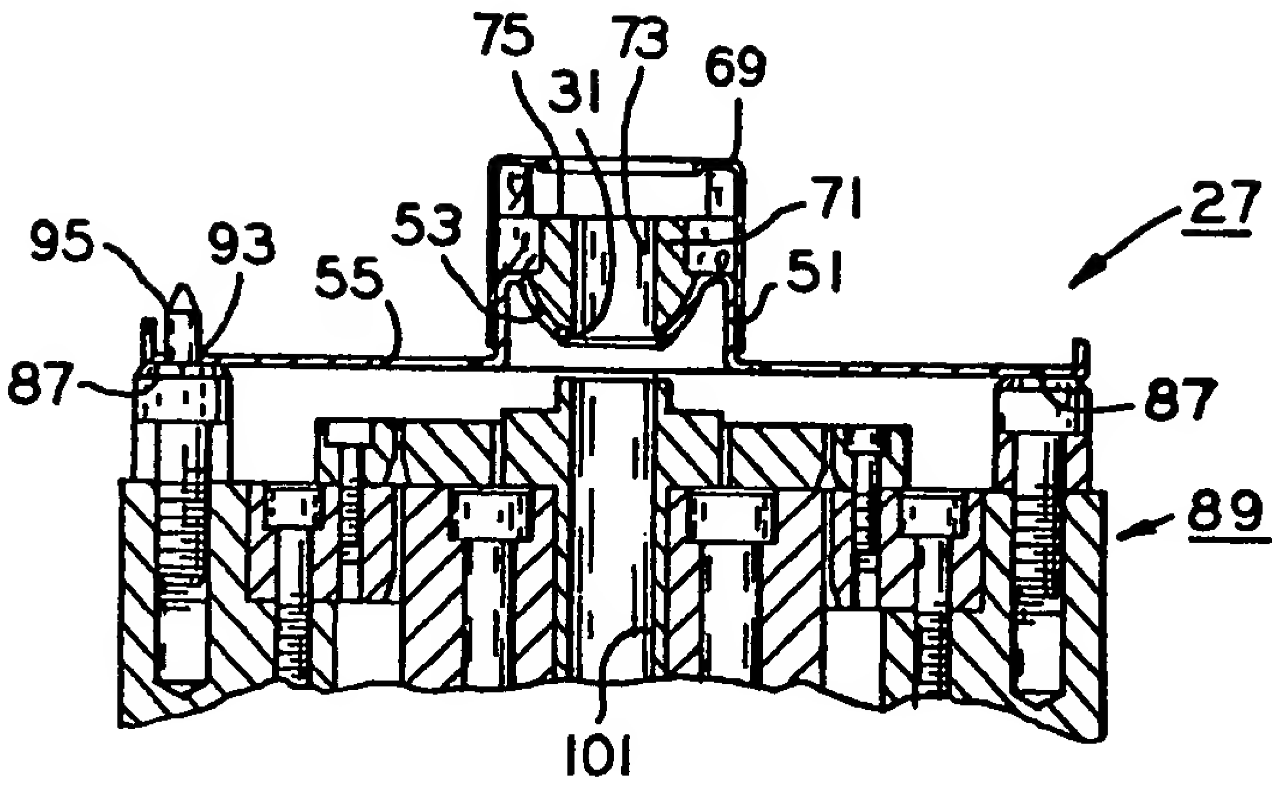


FIG. 2

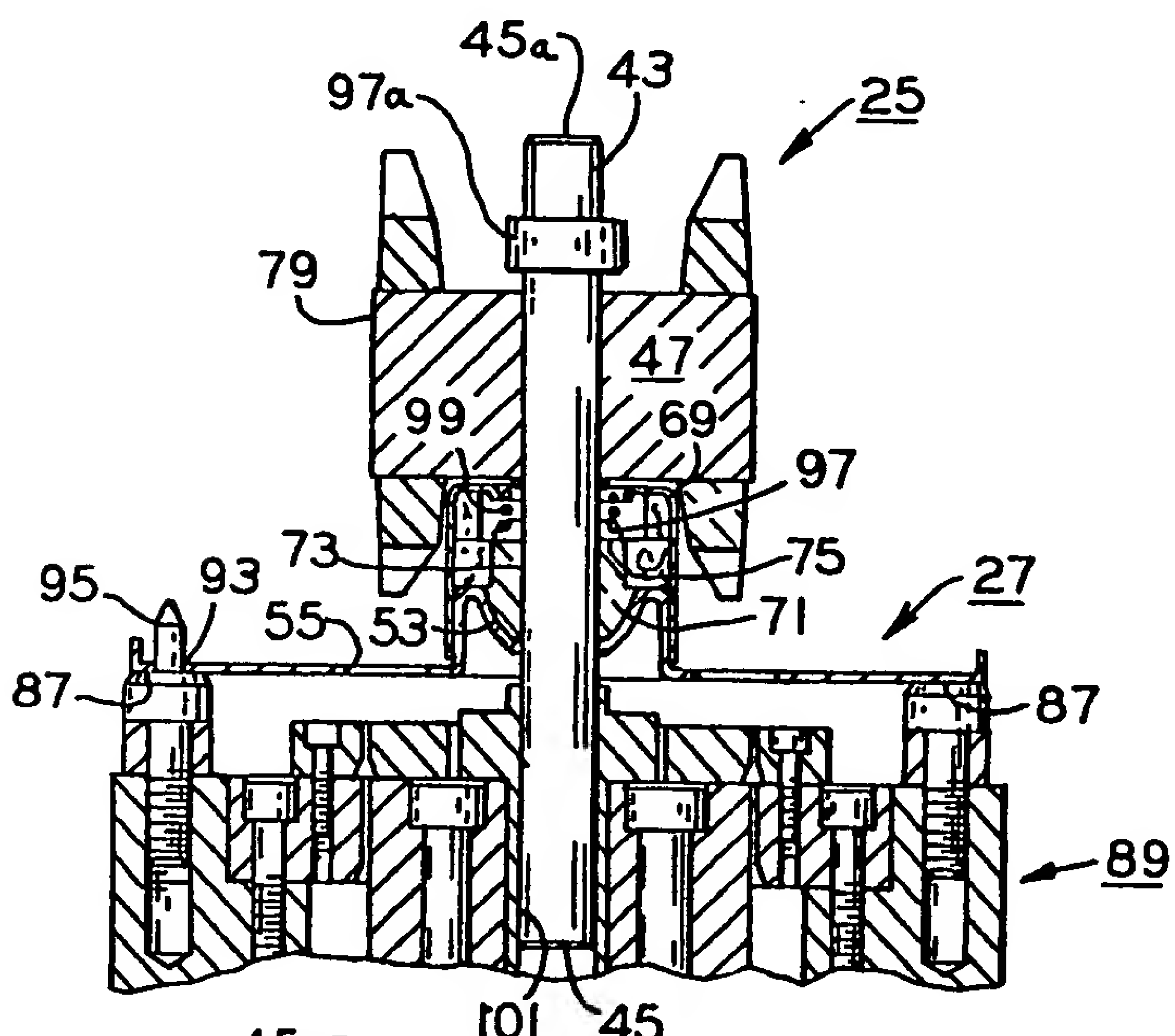


FIG. 3

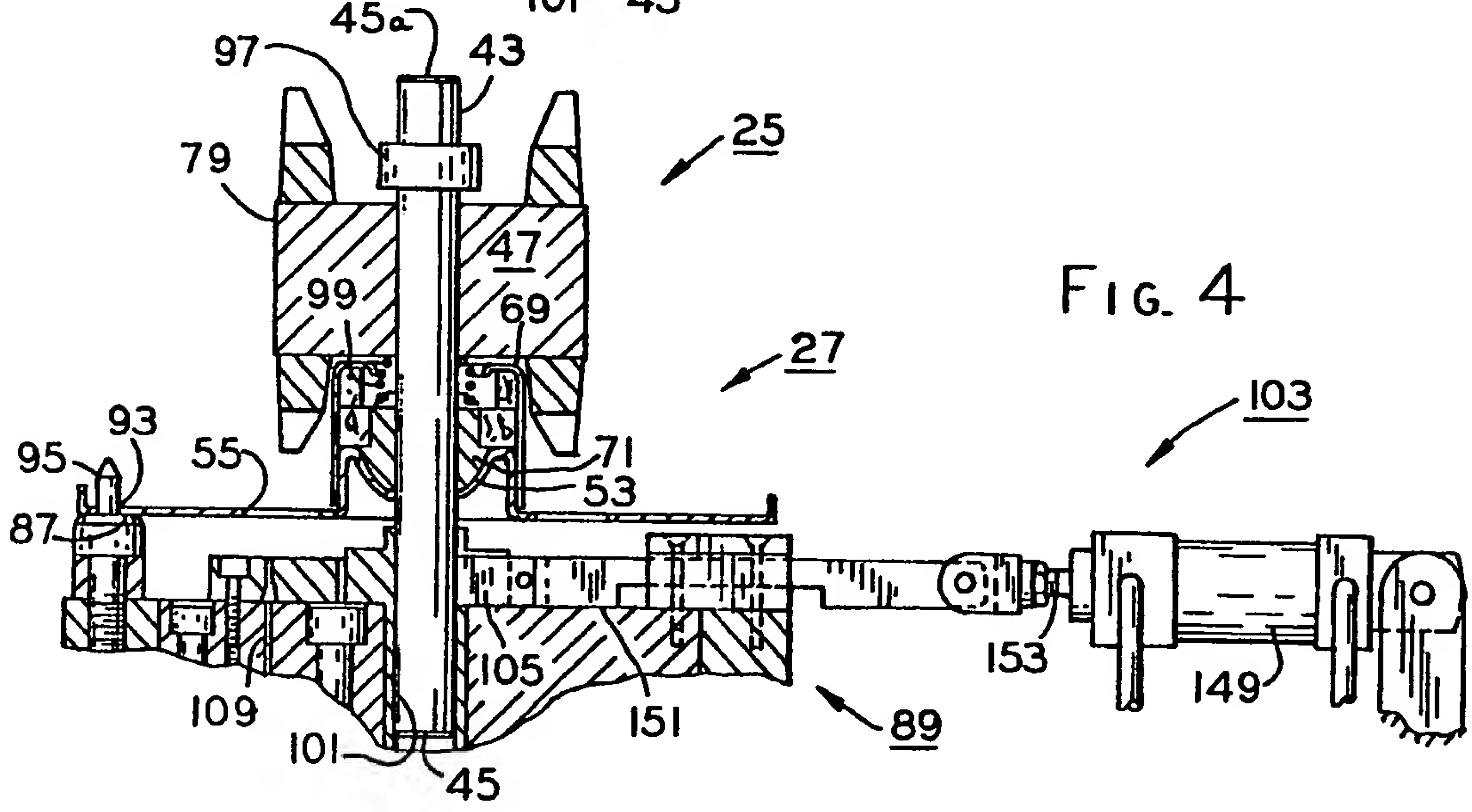


FIG. 4

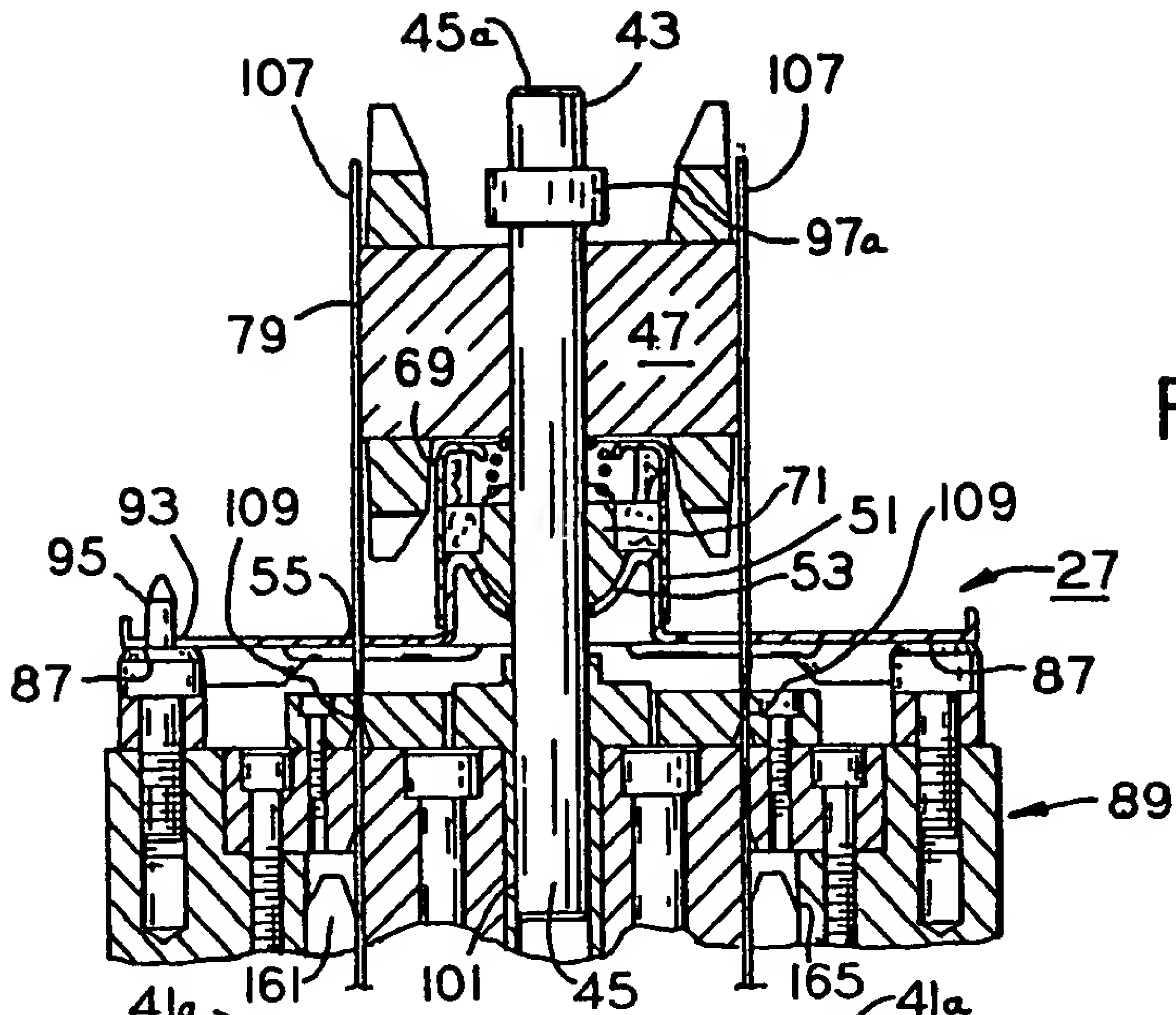


Fig. 5

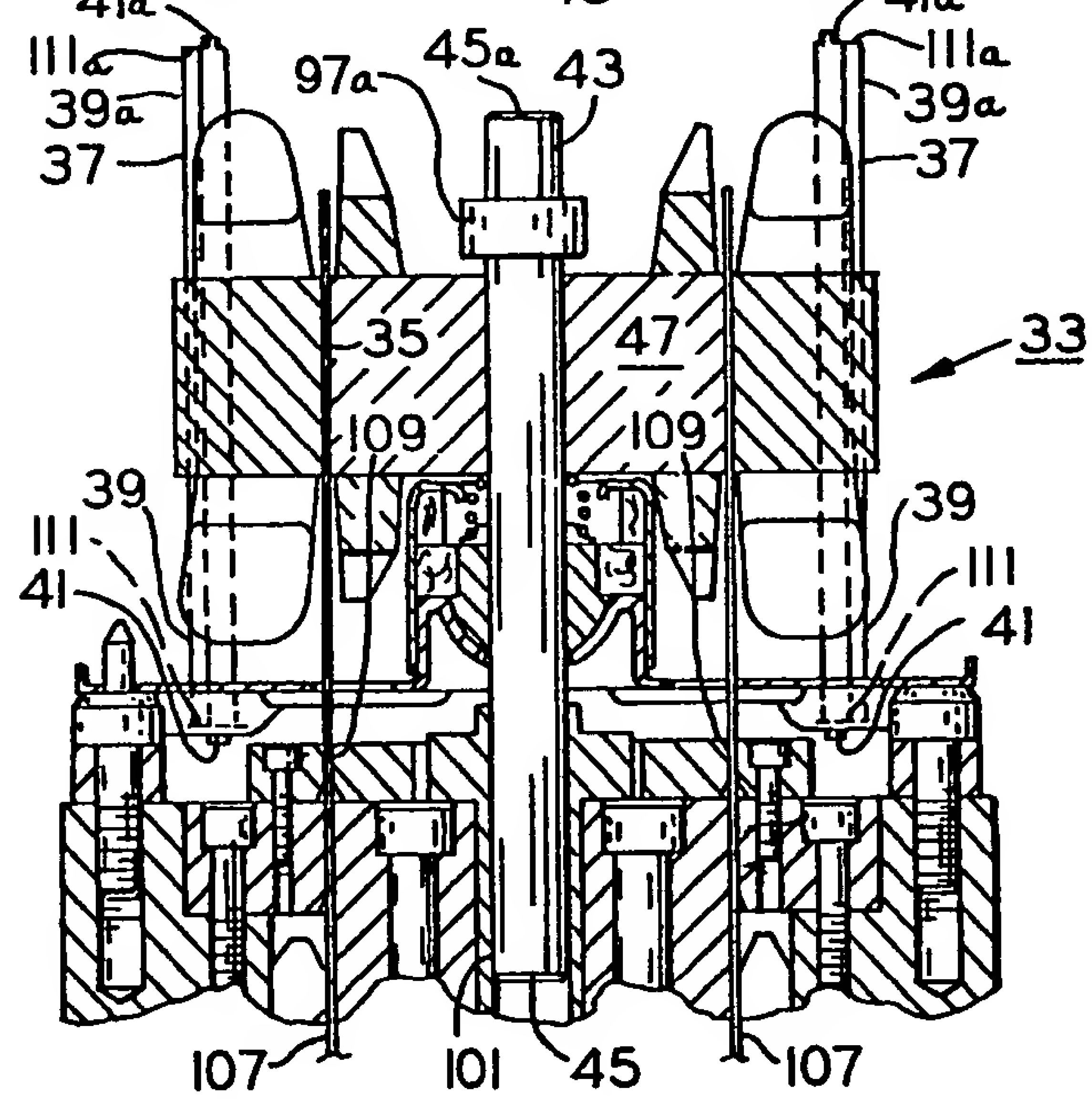


Fig. 6

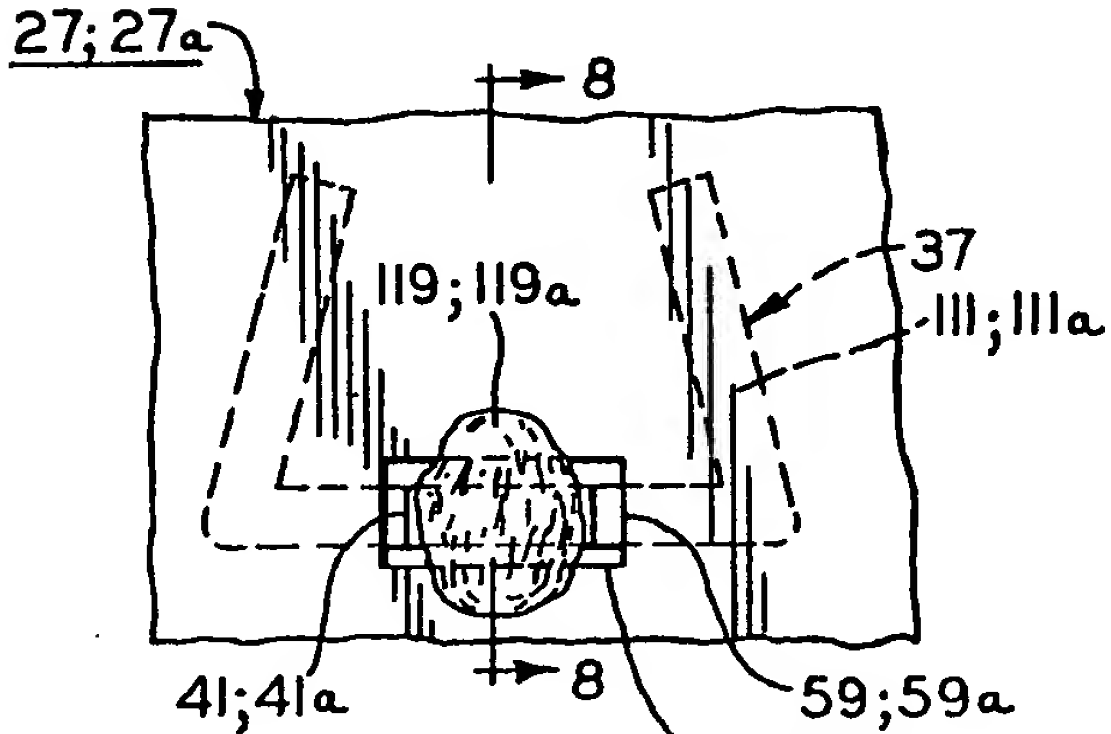


Fig. 7

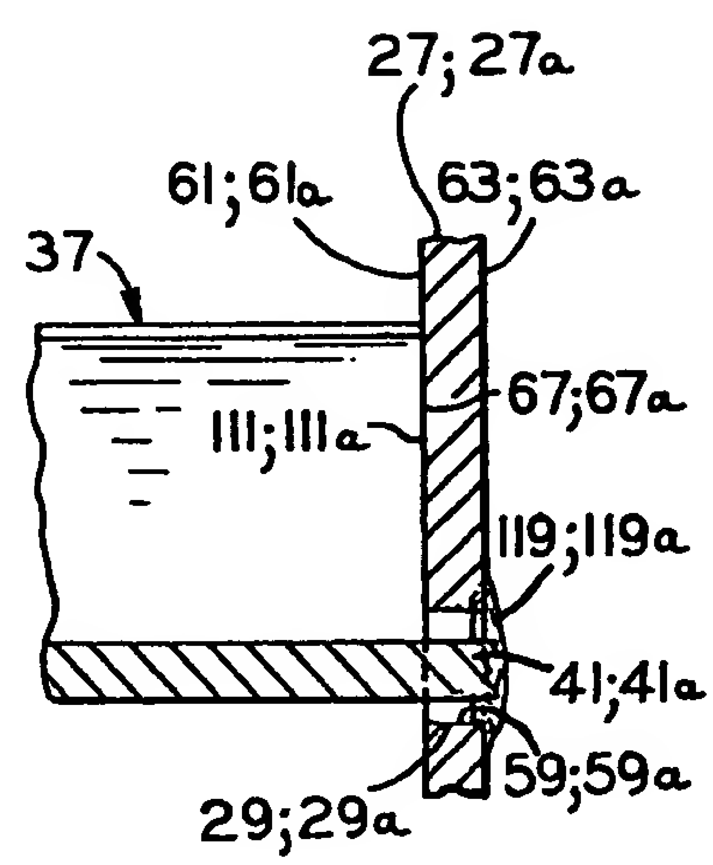


Fig. 8

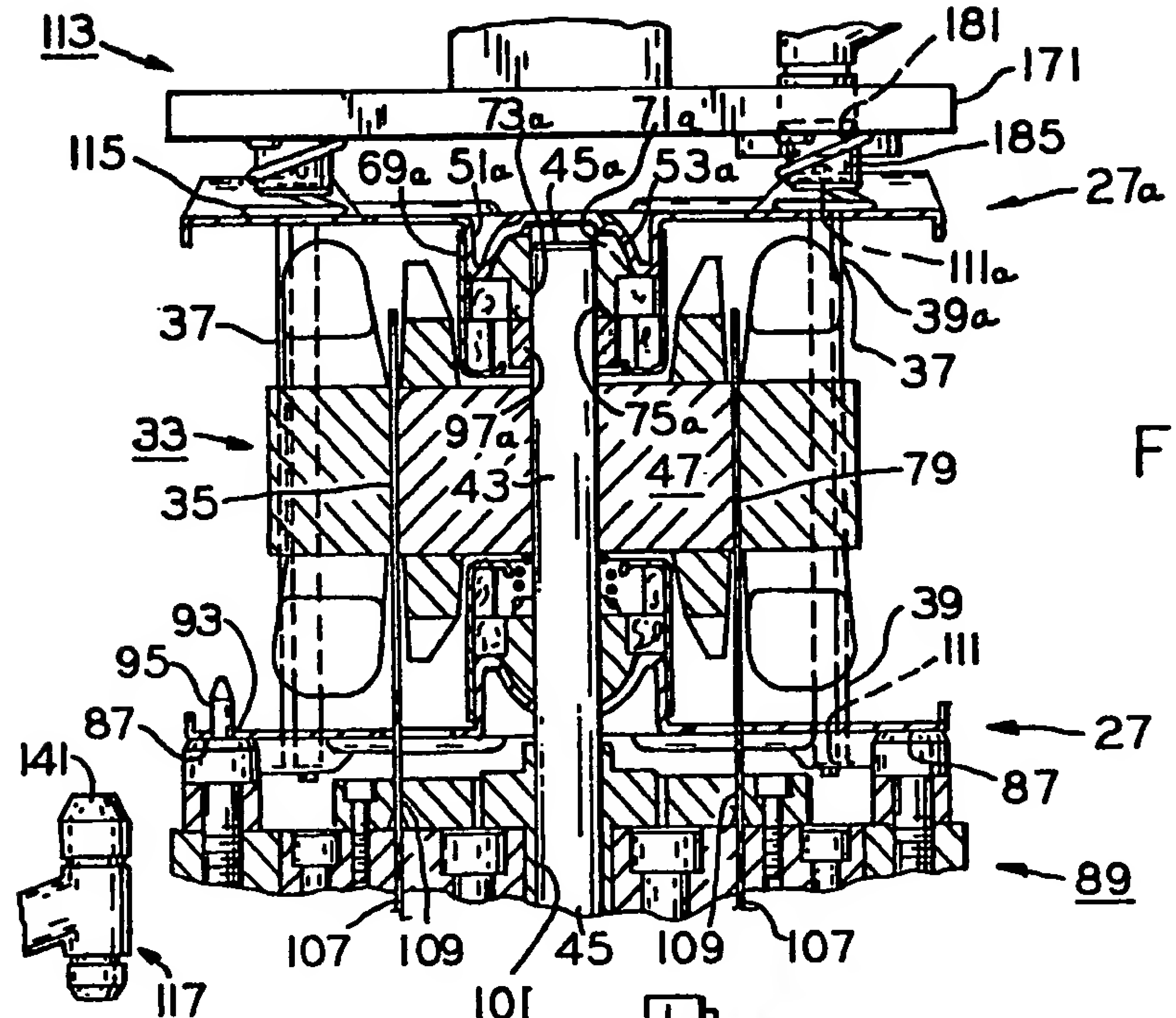
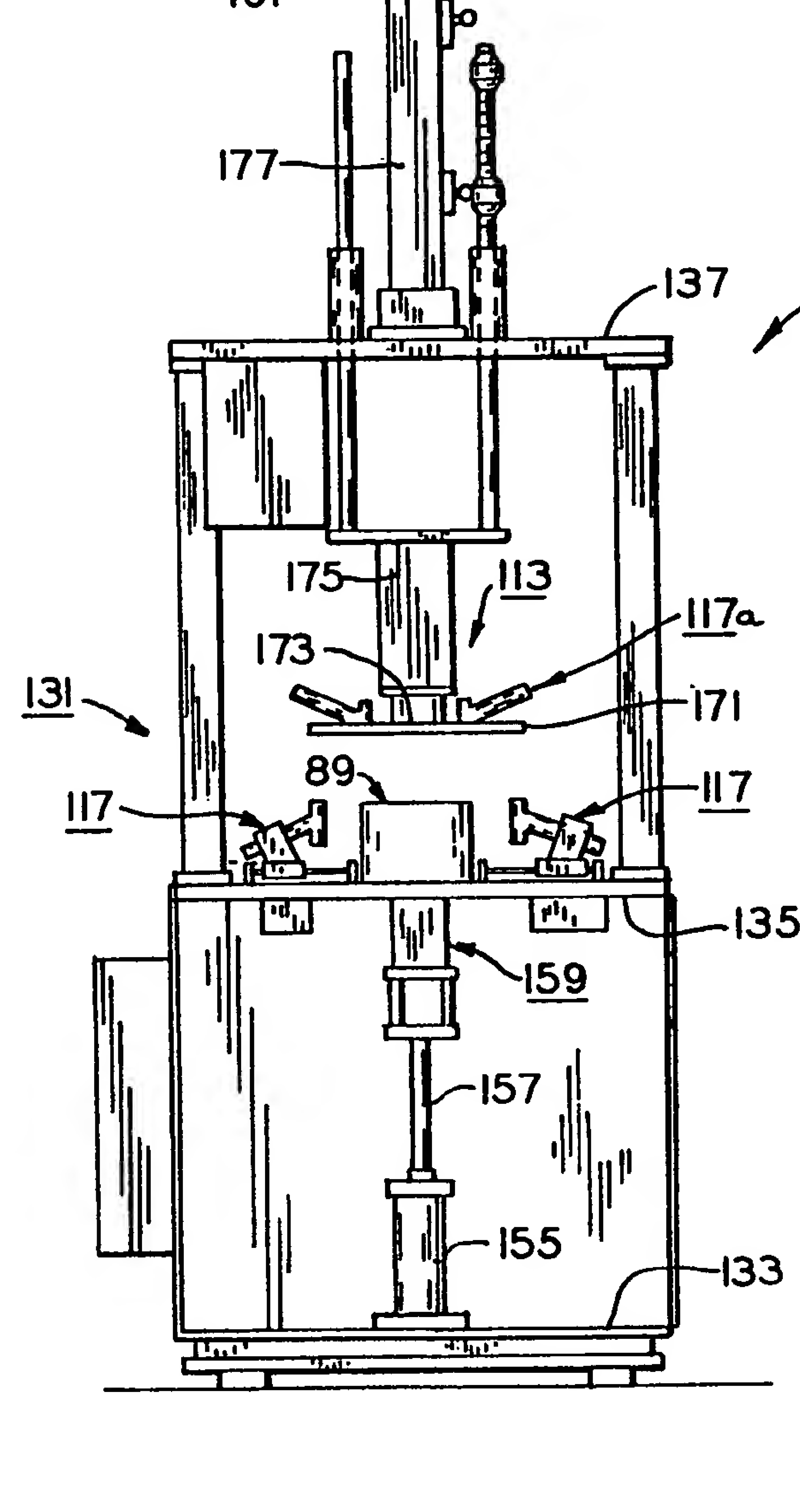

113
181
171
73a
71a
185
115
69a
51a
45a
53a
27a
111a
39a
37
37
75a
97a
33
43
47
79
35
39
93
111
95
27
87
87
141
89
107
109
45
109
107
117
101

FIG. 9


177
137
91
175
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117a
173
131
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89
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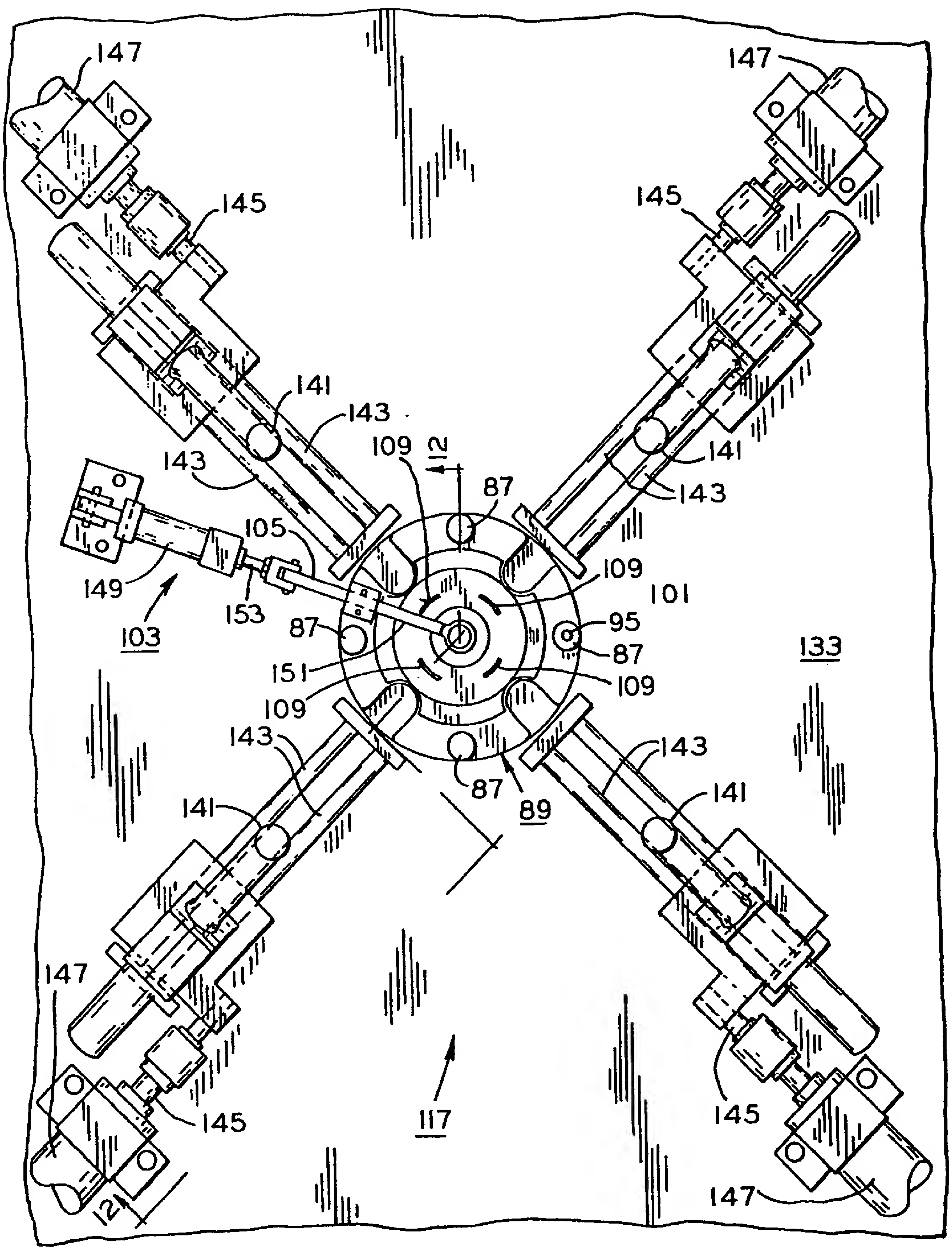
157
155
133

FIG. 10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101
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153
87
95
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117
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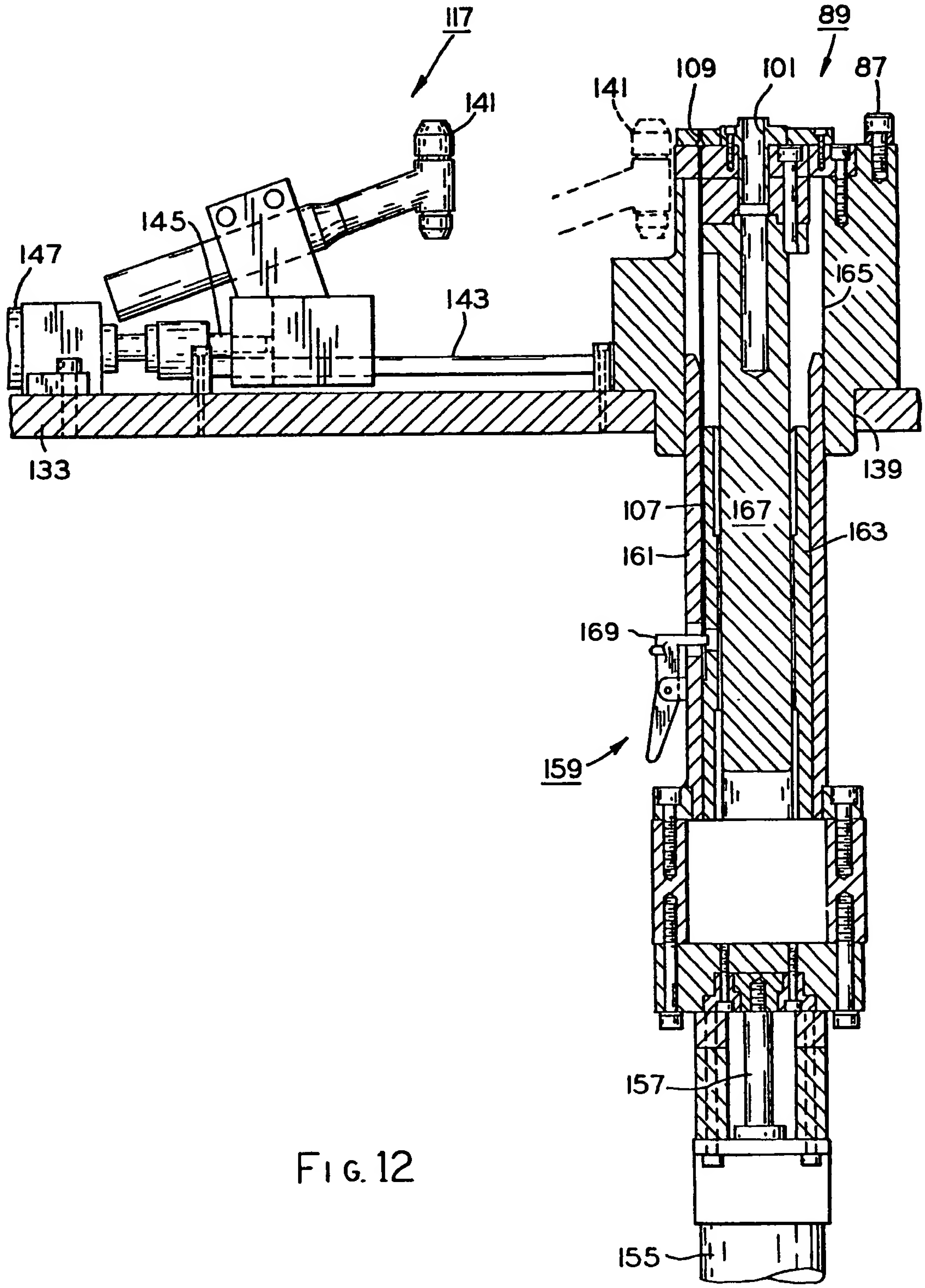
121

FIG. 11


117
89
141
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169
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155

FIG. 12

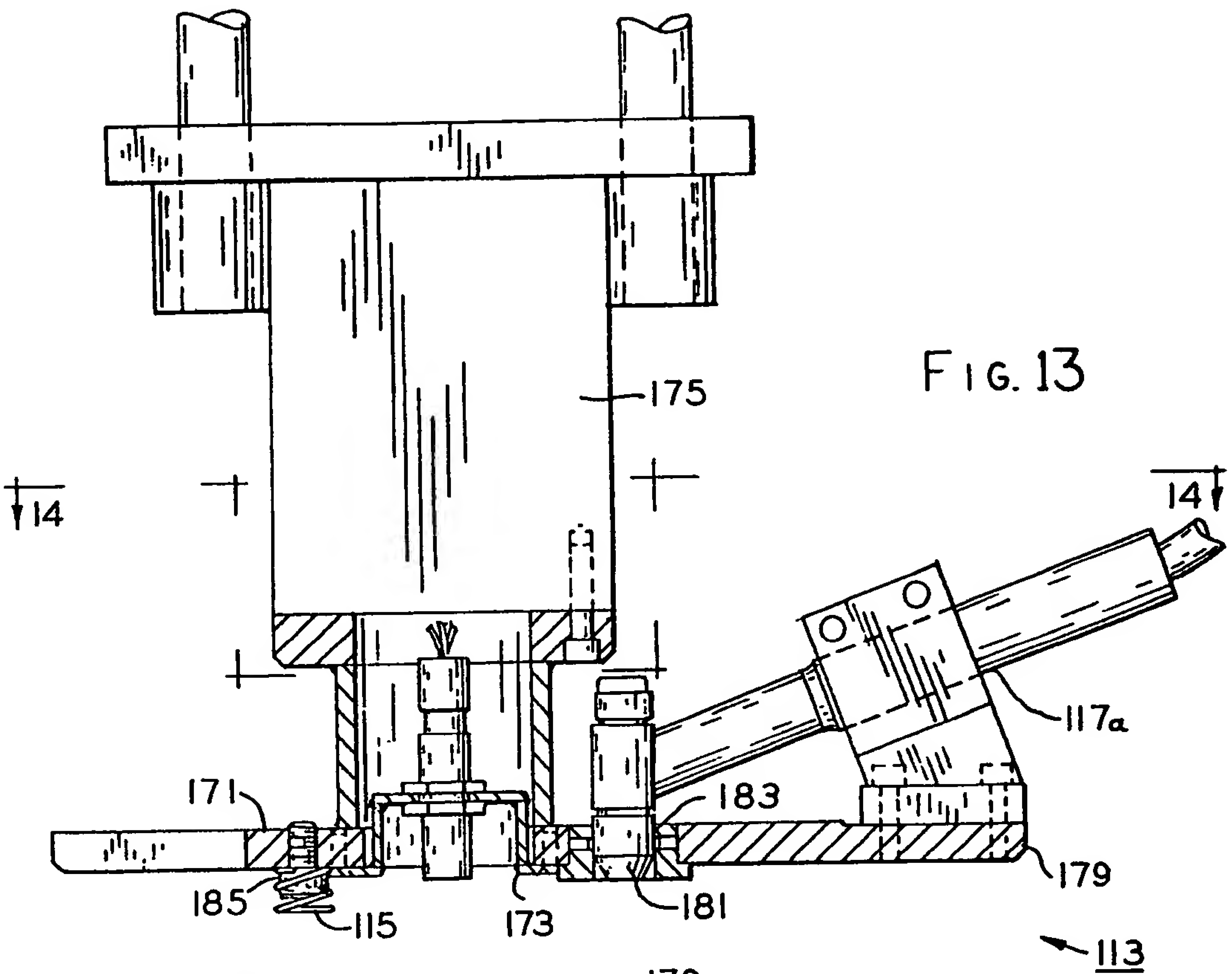
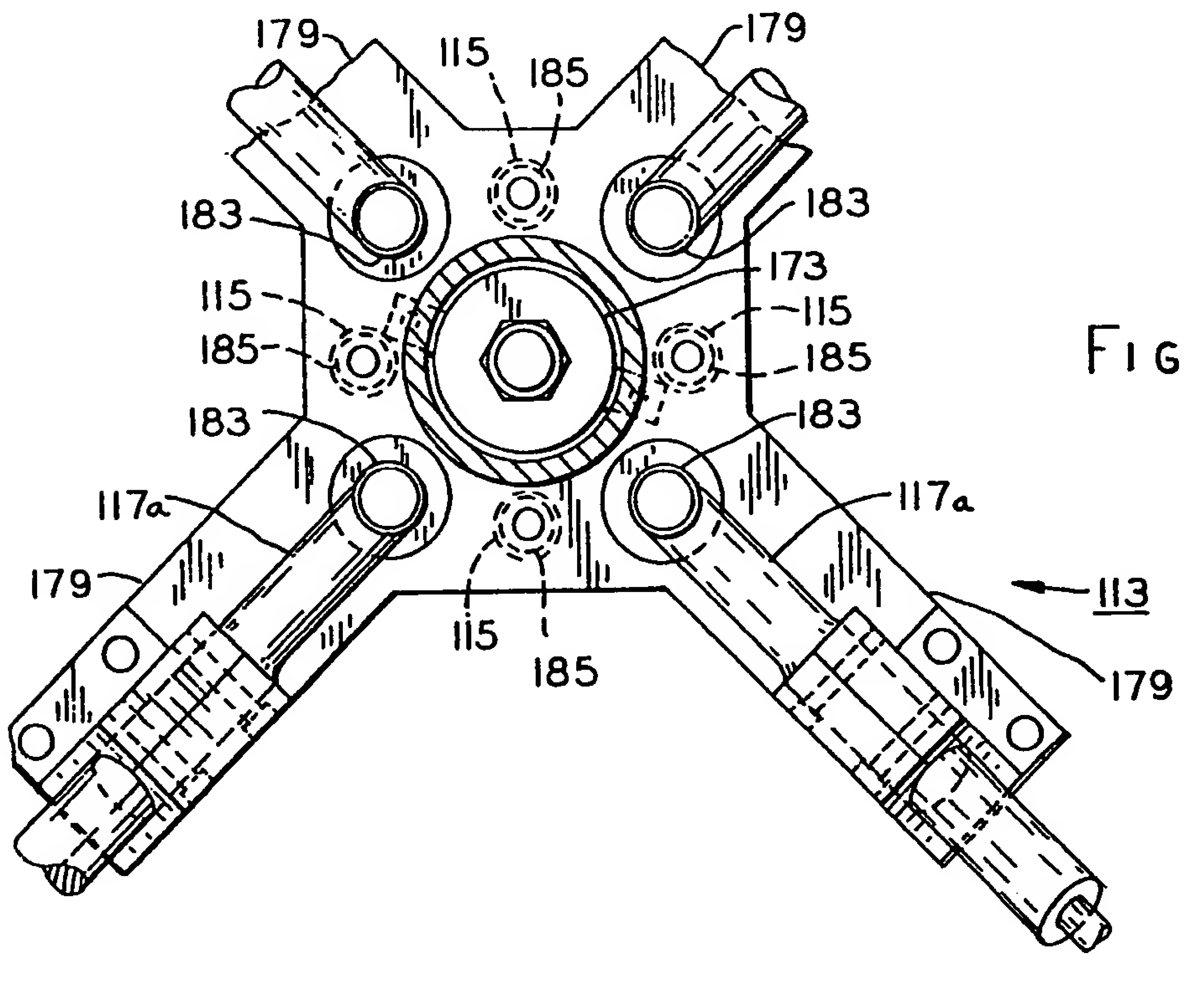

175
14
14
117a
171
183
185
115
173
181
179
113

FIG. 13


179
115
185
179
183
183
173
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115
185
185
183
183
117a
117a
179
115
185
113
179

FIG 14

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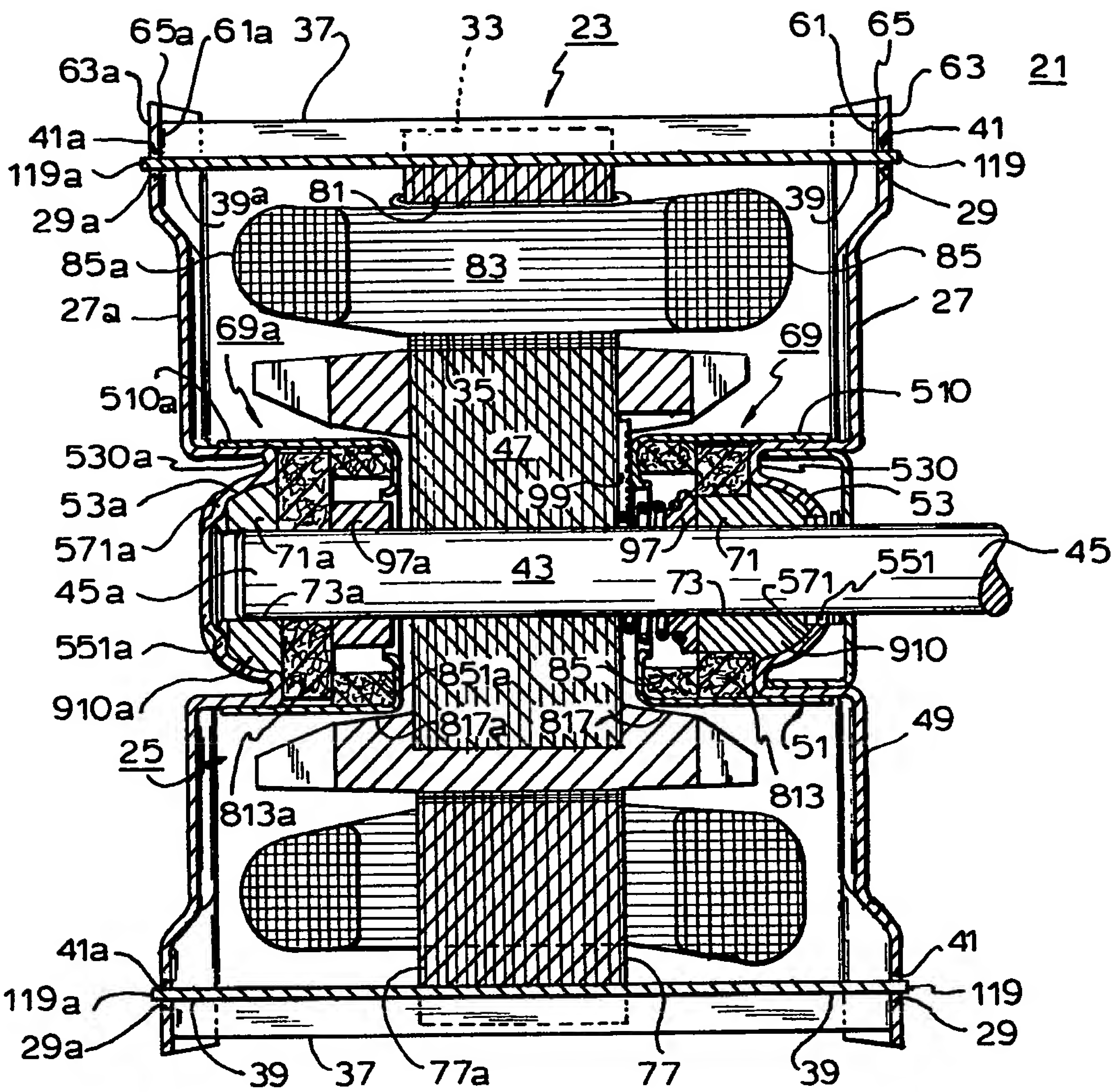
65a
61a
37
33
23
61
65
63
21
63a
41a
41
119a
119
29a
29
39a
81
39
85a
83
85
27a
27
69a
69
510a
35
510
47
530a
530
99
53a
53
571a
71a
97a
97
71
45
43
45a
73a
73
571
551
551a
910
910a
851a
85
25
817a
817
51
49
813a
813
41a
41
119a
119
29a
29
39
37
77a
77
39

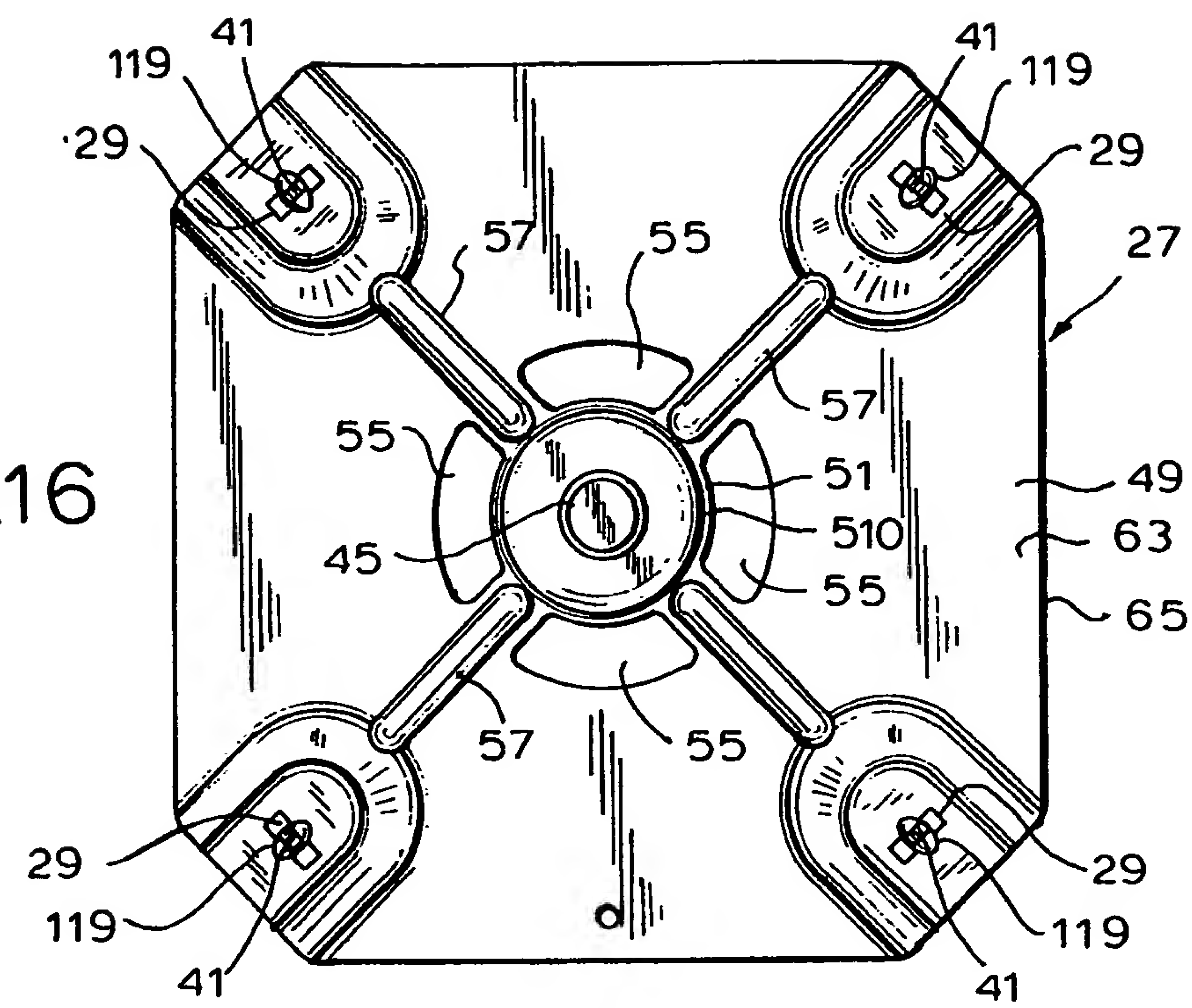
119
41
29
57
55
27
49
63
65
510
51
45
119
41
29

FIG.16

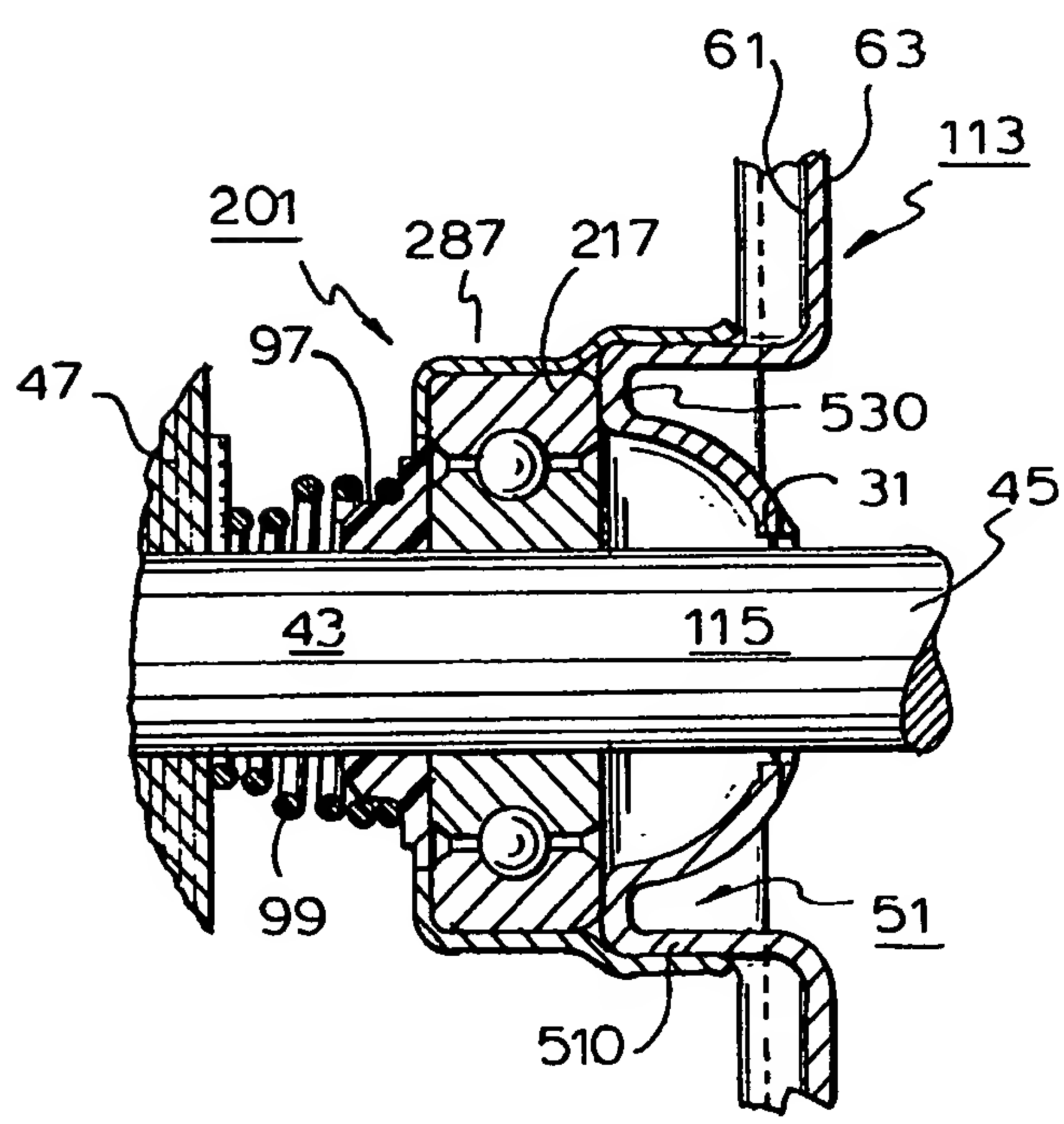
61
63
113
201
287
217
97
47
530
31
45
43
115
99
51
510

FIG.17

SPECIFICATION

Dynamoelectric machines

In general, dynamoelectric machines, such as electric motors, are basically categorized as being of three different types of construction, i.e., a totally enclosed motor, a drip-proof motor and an open motor. One definition of a totally enclosed motor is that it is so enclosed as to prevent the free exchange of air between the inside and the outside of the motor housing but not sufficiently enclosed to be air tight, and an example of such totally enclosed motor is illustrated in U.S. Patent No. 2, 974,856 issued to R.E. Seely on March 14, 1961. A definition of an open motor is that it has ventilating openings which permit passage of external cooling air over and around the windings of such open motor, and examples of such open motor are illustrated in U.S. Patent No. 3,164,422 issued January 5, 1965 to Paul B. Shaffer et al and U.S. Patent No. 3,858,067 issued December 31, 1974 to Charles W. Otto. One definition of a drip-proof motor is that it is an open motor in which the ventilation openings are so constructed that successful operation is not interfered with when drops of liquid or solid particles strike or enter the housing thereof at any angle from about 0° to about 15° downward from the vertical, and an example of such drip-proof motor is illustrated in U.S. Patent No. 3,270,223 issued August 30, 1966 to R.E. Seely. The foregoing definitions of totally enclosed, drip proof and open motors may be found in the C.G. Veinott textbook entitled "Fractional and Subfractional Horsepower Electric Motors" (third edition, McGraw-Hill Book Co.).

In the open motor construction of our aforementioned U.S. Patent No. 3,858,067, a plurality of beams secured to a stator had a pair of opposite end portions received within a plurality of sockets provided in a pair of opposite end frames, respectively. In order to secure the opposite end frames against displacement from the opposite end portions of the beams, metallic plugs were solidified and contained generally within the sockets and were respectively interconnected between the opposite end portions of the beams and at least a portion of the sockets.

Various methods and apparatus have been employed in the assembly of such dynamoelectric machines. For instance, in the method and apparatus disclosed in U.S. Patent No. 3,857,150 issued December 31, 1974 to Jesse A. Stoner, a pair of opposite end frames, a rotor and a stator were aligned with respect to each other so as to compensate for any out-of-square opposite end faces of the stator, and a hardenable material was introduced between opposite end portions of a set of beams carried by the stator and the end frames so as to interconnect the dynamoelectric machine components in their aligned and assembled relation.

In the method and apparatus disclosed in the aforementioned U.S. Patent No. 3,164,422, one end shield of the dynamoelectric machine had a generally central bearing assembly associated therewith and was located in a preselected position on a seat provided on an assembly fixture of the assembly apparatus. When so located on the assembly fixture seat, four spaced apart generally peripheral welding flanges integrally formed with the one opposite end shield extended generally vertically upwardly therefrom. A rotor and shaft assembly included a pair of opposite oil slinger-thrust members secured to opposite ends of the shaft, respectively, and one end of the shaft was inserted through the bearing assembly of the one opposite end shield until the oil slinger-thrust member on such shaft end was seated in engagement with the bearing assembly of the one opposite end shield. A locating recess associated with the assembly fixture of the apparatus was provided to receive the one shaft end of the rotor and shaft assembly generally as it was inserted through the bearing assembly of the one opposite end shield. With the one shaft end so received in the locating recess of the apparatus, the rotor and shaft assembly was located in a preselected position extending generally perpendicularly with respect to the seat of the assembly fixture on which the one opposite end shield was located. After the rotor and shaft assembly and the one opposite end shield were so located in the preselected positions thereof with respect to each other, a shim set of the apparatus was extended through ventilation openings provided therefor in the one opposite end shield into positions about the periphery of the rotor. At this time, a bore of a stator for the dynamoelectric machine was also positioned about the rotor with the shim set in shimming engagement therebetween so as to provide a generally uniform air gap between the periphery of the rotor and the stator bore. As the stator was lowered into position about the rotor, the lower end face was engaged with a plurality of locating pins therefor predeterminately located on the apparatus with respect to the seat on the assembly fixture thereof, and in this manner, the lower end face of the stator was predeterminately located or vertically spaced from the one opposite end shield located on such seat. At the same time, four peripheral welding surfaces of the stator were arranged within the four welding flanges of the one opposite end shield at least closely adjacent thereto. With the stator for the dynamoelectric machine so located on the locating pins of the apparatus and also with respect to the rotor and the one opposite end shield, the bearing assembly of the other of the opposite end shield was passed about the other opposite end of the shaft and into seating engagement with the other of the oil slinger-thrust member secured to the other shaft end. Like the one opposite end shield, the other opposite end shield was also provided with four spaced apart, generally peripheral welding flanges integrally formed therewith and extending generally vertically therefrom. As the bearing assembly of the other opposite end shield was passed about the other shaft end, the four welding flanges on the other opposite end shield were arranged about the four welding surfaces of the stator at least closely adjacent thereto and generally in axially aligned and spaced apart relation with the four welding flanges of the one opposite end shield. Another or opposite upper assembly fixture of the apparatus was gripped in engagement

with the other opposite end shield, and the upper assembly fixture was actuated to apply a force to insure the engagements of the bearing assemblies in the opposite end shields with the opposite oil slinger-thrust members on the opposite ends of the shaft, respectively, thus ensuring that no end play existed between the rotor and shaft assembly and the opposite end shields. Thereafter, the upper assembly fixture of the apparatus was actuated to raise the other opposite end shield a preselected distance, generally between about 0.040" and about 0.050", which concurrently raised or spaced the bearing assembly on the other opposite end shield from its engagement with the oil slinger-thrust member on the other shaft end thereby to insert a preselected amount of end play into the dynamoelectric machine between the rotor and shaft assembly and the opposite end shields thereof. With the upper assembly fixture of the apparatus maintaining the other opposite end shield in its raised position to insure the maintenance of the preselected end play for the dynamoelectric machine, four welding units of the apparatus were then moved into a position for concurrently welding the four welding flanges of the one opposite end shield to the four peripheral welding surfaces of the stator associated therewith. After effecting these welds, the four welding units of the apparatus were subsequently moved into another position for concurrently welding the four welding flanges of the other opposite end shield to the four peripheral welding surfaces of the stator also associated therewith. Subsequent to the welding of the opposite end shields to the stator to effect the final assembly of the dynamoelectric machine in the assembly apparatus, the dynamoelectric machine in its assembled state was removed therefrom.

A particular problem which arises when assembling a dynamoelectric machine is that of avoiding radial stresses sufficient to produce a non-uniform air gap between the rotor and the surrounding bore of a stator. Non-uniformity of the air gap may also occur due to warpage of the opposite end frames as well as skew in the bore of the stator.

In accordance with one aspect of the present invention there is provided a method of securing a set of beams of a stationary assembly for a dynamoelectric machine to a pair of opposite end frames thereof, the opposite ends of the beams having respective tabs extending therefrom, and the end frames each having a set of apertures extending therethrough, the apertures being sized predeterminately larger than the tabs, and the method comprising: locating the tabs at the opposite ends of the beams at least in part within the respective apertures in the end frames and spacing the tabs from the sidewalls of the apertures; and welding generally simultaneously at least a part of the end frames adjacent the respective apertures to at least a part of each tab located therein.

In accordance with another aspect of the present invention there is provided a method of assembling a dynamoelectric machine having a stationary assembly and a rotatable assembly, the stationary assembly including: a pair of opposite end frames with respective sets of apertures extending therethrough, a stator, and a set of beams secured to the stator, the opposite ends of the beams being provided with respective oppositely extending tabs; and the rotatable assembly including a rotor secured to the shaft between opposite end portions thereof, the method comprising: locating one end frame and the rotatable assembly generally in preselected positions with one of the shaft end portions extending through a generally central opening in the end frame; aligning a bore of the stator at least in part about the rotor to define an air gap therebetween; receiving the tabs at one end of the beams within respective apertures of the set in the located end frame; disposing the apertures of the set in the other end frame generally about the tabs at the other ends of the beams; and welding the end frames at least generally adjacent the respective aperture sets to at least a part of each tab within the respective apertures.

In accordance with a further aspect of the present invention there is provided a dynamoelectric machine comprising: an end frame having an aperture intersecting opposite faces of the frame; a beam supporting the frame and including an abutment surface abutting one of the said opposite faces adjacent its intersection with the aperture, a tab integral with the abutment surface and extending generally axially therefrom at least in part through the aperture, a free end of the tab being spaced adjacent the other of the said opposite faces and the tab being sized predeterminately smaller than the aperture thereby to predeterminately define a space between a sidewall of the aperture and the tab; and weld means spanning the space between the sidewall and the tab for interconnecting the end frame with the free end of the tab at least adjacent the intersection of the sidewall with the said other face of the frame and thereby predeterminately maintaining the space between the tab and the sidewall.

In accordance with a further aspect of the present invention there is provided a dynamoelectric machine comprising: a pair of opposite end frames each having a set of apertures extending therethrough; a set of beams each with opposite end portions having respective tabs extending at least in part through corresponding apertures in the respective end frames, the tabs being sized predeterminately smaller than the apertures and being predeterminately arranged in spaced apart relation with the apertures; and each end frame being interconnected by respective sets of welds adjacent the apertures with at least a part of each of the tabs.

In accordance with a still further aspect of the present invention there is provided apparatus for securing a set of beams on a stationary assembly for a dynamoelectric machine to a pair of opposite end frames thereof, the beams having a pair of sets of tabs on opposite end portions thereof, respectively, and the end frame having a pair of sets of apertures extending therethrough predeterminately larger than the tabs, respectively, the apparatus comprising: means for locating one of the end frames with one of the opposite ends of at least one of the beams being seated thereon and with one of the tabs on the

one opposite ends of the beams being received in one of the aperture sets of the one end frame in spaced apart relation therefrom, respectively; means for biasing the other of the end frames against the other of the opposite ends of at least two of the beams with the other of the tabs on the other opposite ends of the beams being received in the other of the aperture sets in the other end frame in spaced apart relation therefrom, respectively; and means for generally simultaneously welding at least a part of each of the one and other tabs to a part of the one and other end frames at least generally adjacent each aperture of the one and other aperture sets when the tabs and the aperture sets are in the spaced apart relation thereof, respectively.

In the accompanying drawings, by way of example only:-

Figure 1 is an exploded perspective view of a dynamoelectric machine;

Figures 2-6 and *9* are partial sectional views illustrating a method of assembling the dynamoelectric machine of Figure 1;

Figure 7 is an enlarged partial elevational view of an end frame of the dynamoelectric machine of Figure 1 showing an aperture thereof with a tab of one beam on a stator of the dynamoelectric machine received therein;

Figure 8 is a sectional view taken along line 8—8 in Figure 7;

Figure 10 is a schematic front elevational view of an apparatus for assembling the dynamoelectric machine of Figure 1;

Figure 11 is a plan view of a lower assembly fixture of the apparatus of Figure 10, partial sectional views of the lower assembly fixture being shown in Figures 3 and 4;

Figure 12 is a partial sectional view taken along line 12—12 in Figure 11;

Figure 13 is an enlarged partial side elevational view of an upper assembly fixture of the apparatus of Figure 10, a section of the upper assembly fixtures being shown in Figure 9;

Figure 14 is a top elevational view of the upper assembly fixture of Figure 13;

Figure 15 is an enlarged sectional view showing the dynamoelectric machine of Figure 1 in cross section;

Figure 16 is a right side elevational view of the dynamoelectric machine of Figure 15;

Figure 17 is a partial sectional view illustrating an alternative bearing construction for the dynamoelectric machine of Figure 1 and associated with the end frame thereof.

Corresponding reference characters indicate corresponding parts throughout the different figures of the drawings.

Referring to the drawings in general, there is illustrated a dynamoelectric machine 21 having a stationary assembly 23 and a rotatable assembly 25 (Figures 1-9). Stationary assembly 23 has a pair of opposite end frames 27, 27a with a pair of sets of apertures 29, 29a therethrough, respectively, and with a generally central opening 31 in end frame 27 (Figure 1). A stator 33 of stationary assembly 23 has a bore 35 therethrough, and a set of beams 37 is secured to the stator. Beams 37 are fixed to stator 33 adjacent a peripheral surface thereof. A more detailed description of the construction and attachment of the beams to the stator may be found in our aforesaid U.S. Patent No. 3,858,067.

A pair of sets of opposite ends 39, 39a on beams 37 are provided with a pair of sets of oppositely extending tabs 41, 41a, respectively (Figure 1). Rotatable assembly 25 includes a shaft 43 having a pair of opposite end portions or extensions 45, 45a, and a rotor 47 is secured to the shaft between the end portions thereof (Figure 1). End frame 27 and rotatable assembly 25 are located generally in preselected or assembly positions with shaft end portions 45 extending through central opening 31 of the end frame (Figures 2 and 3). Stator bore 35 is aligned at least in part about rotor 47 of rotatable assembly 25 to define a desired or predetermined air gap therebetween, and tabs 41 on opposite ends 39 of beams 37 are received within apertures 29 in end frame 27 with the tabs and apertures being predeterminately arranged in spaced apart relation, respectively (Figures 5-8). Apertures 29a in end frame 27a are disposed generally about tabs 41a on opposite ends 39a of beams 37 with the tabs and apertures being predeterminately arranged in spaced apart relation, and end frames 27, 27a are conjointly welded at least generally adjacent apertures 29, 29a therein to tabs 41, 41a received within the aperture with the spaced apart relation between the tabs and apertures being maintained, respectively (Figure 7).

More particularly, and with specific reference to Figures 1 and 15, end frames 27, 27a are lanced or otherwise formed from a metallic sheet, such as sheet steel. Since the two end frames are substantially identical, only end frame 27 will be further described with like parts of end frame 27a being designated by the letter "a".

A generally planar section 49 of end frame 27 extends about a central portion of the end frame which includes an integral hub recessed portion 51. Hub 51 has a generally cylindric axially extending sidewall 510 and a base wall 530 which is integral with the sidewall, a shaft receiving opening 31 being provided through the base wall. Base wall 530 defines a partial spherical bearing seating surface 53 having at least one key 551 deformed therefrom for at least limited rotational preventing engagement with a keyway 571 provided on a bearing 71 of the self-aligning type, as discussed in greater detail hereinafter.

The planar section 49 of end frame 27 includes ventilation openings 55 disposed about the hub 51, and a plurality of strengthening ribs 57. Apertures in the form of elongate slots 29 each having a sidewall 59 extend between opposite sides of faces 61, 63 of end frame 27, the apertures being arranged in preselected locations generally radially outwardly of hub 51 and generally adjacent a marginal edge or circumferential portion 65 of the end frame. A set of beam seating surfaces 67 are provided on the face 63 of end frame 27 adjacent the intersection of aperture sidewalls 59 with the face 63. While bearing seating surface 53a of end frame 27a is illustrated as being closed, as seen in Figure 9, it is contemplated that a

shaft receiving opening similar to opening 31 in end frame 27 may be provided.

A pair of lubrication and bearing systems 69, 69a are respectively associated or preassembled with end frames 27, 27a about hub portions 51, 51a thereof, the systems including respective self-aligning bearings or bearing means 71, 71a having shaft journalling bores 73, 73a and thrust taking surfaces 75, 75a extending generally about the bores. Since lubrication and bearing systems 69, 69a are generally of like construction, only lubrication and bearing system 69 will be discussed in detail with corresponding components of lubrication and bearing system 69a being designated by the letter "a".

Referring particularly to Figure 15, lubrication and bearing system 69 comprises bearing 71, a lubricant feeder wick device 813, a lubricant storage wicking material 815 and a cover container 817 for containing the lubricant storage wicking material. A shaft receiving or journalling bore 73 extends generally axially through bearing 71 which is of the self-aligning type having a partial spherical bearing surface 910 seated in self-aligning bearing relation with bearing seating surface 53 on base wall 530 of end frame 27. Keyway 571 of bearing 71 is provided in an end thereof adjacent bearing surface 910 and is arranged in at least limited anti-rotational engagement with key 551 of bearing seating surface 53 on end frame 27. While the engagement of key and keyway 551, 571 does provide at least limited anti-rotational seating of bearing 71 on seating surface 53 therefor, such engagement of the key and keyway does permit a desirable amount of self-aligning movement of partial spherical bearing surface 910 of bearing 71 on seat 53 therefor of end frame 27. It may be noted that the aforementioned predetermined spaced relation between tabs 41, 41a on beams 37 and sidewalls 59, 59a of apertures 29, 29a in end frames 27, 27a is instrumental in ensuring sufficient self-alignment of bearings 71, 71a associated with the end frames and journalling shaft 43 so as to assure the uniformity of the air gap between stator bore 35 and rotor 47 as well as the free rotation of rotatable assembly 25 in stationary assembly 23.

Feeder wick 813 is in lubricant wiping engagement with a part of shaft end portion 45 journalled in bore 73 of the bearing 71 and in lubricant transfer engagement with lubricant storage wicking material 815. Feeder wick 813 may consist of a material such as felt, and lubricant storage wicking material 815 may consist of a material such as absorbent wool or "GE Lube" available from the General Electric Company, Fort Wayne, Indiana. Bearing 71, feeder wick 813 and lubricant storage wicking material 815 are disposed within container 817 which is an open-ended cup-shaped member having one end secured about hub 51 of end frame 27.

With reference to Figure 17, an alternative lubrication and bearing system 201 is illustrated. It has generally the same components functioning generally in the same manner as discussed above, but with the following exceptions.

End frame 213 may, if desired, be the same as end frame 27, and a sealed bearing, such as ball bearing 215 has an outer race 217 received in rotation preventing engagement within a container 287 and an inner race received about shaft end portion 45 for joint rotation with shaft 43 upon energization of the dynamoelectric machine 21. In this alternative system, container 287 is generally the same as container 817 except that container 287 is stepped, and bearing outer race 217 is axially abutted between a part of end wall 530 on hub 51 of end frame 213 and an end flange of container 287 opposite end wall 530. The opposite end frame may include a like sealed bearing associated in the same manner with shaft end portion 45a, and thrust devices 97, 97a may be associated in the same manner with the inner races of the inner races of the sealed bearings in the opposite end frames.

The stator 33 has a pair of opposite end faces 77, 77a interconnected by a peripheral surface 79 to which beams 37 are fixed. Bore 35 of stator 33 intersects stator end faces 77, 77a, and a plurality of slots 81 are also provided intersecting both the stator bore and the stator end faces. Winding means 83, such as a plurality of conductor turns or coils, is disposed in slots 81 with suitable insulation therebetween, and the winding means has a pair of opposite, generally annular groupings of end turns 85, 85a disposed about stator bore 35 adjacent the respective stator end faces 77, 77a.

In assembling dynamoelectric machine 21, end frame 27 is located or oriented in a preselected assembly position on a location seat 87 provided on a lower fixture 89 of an apparatus 91 for assembling the dynamoelectric machine, as best seen in Figures 2 and 10-13. As end frame 27 is placed on location seat 87 in Figure 2, an orientation or locating opening 93 in the end frame is passed over or received about a locating or orientation pin 95 predeterminately arranged on lower assembly fixture 89 with respect to location seat 87 thereof. Thus, with end frame 27 so disposed in its preselected position on location seat 87 and with pin 95 extending through orientation opening 93 in the end frame, the end frame is arranged in its assembly position with respect to lower assembly fixture 89 for subsequent assembly with other components of dynamoelectric machine 21.

A pair of thrust taking devices, such as thrust collars 97, 97a, are assembled about opposite end portions 45, 45a of shaft 43, respectively. A thrust spring 99 is biased between a part or end face of rotor 47 and thrust collar 97 which is slidable on shaft end portion 45, while thrust collar 97a is fixed in gripping engagement about shaft end portion 45a. The assembly of thrust collars 97, 97a and thrust spring 99 onto shaft 43 may be accomplished either before, after, or generally simultaneously with the above discussed placement of end frame 27 on location seat 87. Shaft end portion 45 is then passed or inserted through bore 73 in bearing 71 of lubrication and bearing system 69 on end frame 27 and also through central opening 31 thereof, and thrust collar 97 is moved into engagement with thrust taking surface 75 on the bearing, as best seen in Figure 3. With thrust collar 97 so seated against

bearing 71, shaft end portion 45 is moved further through bearing bore 73 and central opening 31 of end frame 27 into guiding and locating engagement with a locating recess, such as sleeve 101, provided in lower assembly fixture 89. In response to this further movement of shaft end portion 45 into locating recess 101, thrust spring 99 is compressed in caged relation between rotor 47 and thrust collar 97 seated against bearing 71. When shaft end portion 45 is so received in locating recess 101, it may be noted that rotatable assembly 25 is located in a preselected or assembly position with respect to end frame 27 on location seat 87, and in this assembly position, the rotational axis of the rotatable assembly is arranged so as to be generally coincidental with an assembly axis A of lower assembly fixture 89, i.e. generally perpendicular to location seat 87 of the lower assembly fixture and to end frame 27 in its located assembly position thereon.

A locking mechanism 103 associated with lower assembly fixture 89 may be actuated by suitable means, as discussed in greater detail hereinafter, so as to displace a plunger 105 thereof into holding or locking engagement with a part of shaft end portion 45 within locating recess 101. In this manner with plunger 105 of locking mechanism 103 in the holding engagement thereof with shaft end portion 45, rotatable assembly 25 is retained in its assembly position against displacement movement in response to the compressive force of thrust spring 99 acting thereon, as best seen in Figure 4. In other words the locking engagement of plunger 105 with shaft end portion 45 in locating recess 101 acts to cage thrust spring 99 in its compressed state between rotor 47 and thrust collar 97 biased against thrust surface 75 of bearing 71, and the caging of the thrust spring by locking mechanism 103 retains the shaft end portion against displacement from the locating recess thereby to maintain rotatable assembly 25 in its assembly position.

With rotatable assembly 25 so maintained in its preselected position by locking mechanism 103, as discussed above, a set of shims 107 may be passed or extended through a set of shim openings or passage means 109 provided therefor through lower assembly fixture 89 and also through ventilation openings 55 in end frame 27 which are aligned with the shim openings, and the shims are thereby positioned or disposed generally about peripheral surface 79 of rotor 47, as best seen in Figure 5.

With shims 107 so disposed about peripheral surface 79 of rotor 47, as discussed above, bore 35 of stator 33 may be arranged or otherwise aligned about the rotor peripheral surface with the shims extending in shimming engagement therebetween so as to predeterminately define or establish the aforementioned desired generally uniform air gap between the stator bore and the rotor peripheral surface, as best seen in Figure 6. While it is preferred that bore 35 of stator 33 be axially perpendicular to the opposite end faces of the stator, such bores in some stators may be skewed slightly with respect to the stator end faces. However, even if bore 35 of stator 33 is skewed, the disposition of shims 107 in shimming engagement between the stator bore and peripheral surface 79 of rotor 47 serves at least in part to assure the establishment of the generally uniform air gap therebetween.

Generally as stator bore 35 is disposed about rotor 47 and shims 107, as discussed above, tabs 41 on opposite end portions 39 of beams 37 are passed or inserted at least in part through apertures 29 in end frame 27 while the end frame is disposed in its preselected position on seat 87 of lower assembly fixture 89. It may be noted that sidewalls 59, 59a of apertures 29, 29a are predeterminately sized so as to be predeterminately larger than tabs 41, 41a received therein, respectively, as best seen in Figures 7 and 8. Thus, when tabs 41 are received in aperture 29 of end frame 27, the tabs are predeterminately arranged in spaced apart relation from sidewalls 59 of the apertures, respectively. It may be further noted that even if bore 35 of stator 33 is somewhat skewed when it is disposed about rotor 47 with shims 107 in shimming engagement therebetween, as previously discussed, the predetermined sizing of tabs 41, 41a and apertures 29, 29a to establish the spaced apart relation therebetween is effective to accommodate such stator bore skew.

On occasions, due to improper manufacturing and/or handling techniques, thermal shrinkage, and/or expansion of the material from which the end frames are formed, the end frames 27, 27a may become warped or otherwise deformed from their desired configuration. In such cases it may be further noted that the predetermined sizing of tabs 41, 41a and apertures 29, 29a to establish the spaced apart relation therebetween is also effective to accommodate such warpage. Accordingly, the predetermined spaced apart relation of tabs 41 from sidewalls 59 of apertures 29 when the tabs are received therein, as discussed above, not only accommodates undesirable skew in bore 35 of stator 33 but also undesirable warpage in end frame 29 during the assembly of dynamoelectric machine 21.

A pair of sets of opposite facing abutment surfaces 111, 111a are provided on opposite end portions 39, 39a of beams 37, and tabs 41, 41a extend generally axially from the abutment surfaces, respectively, as best seen in Figures 1 and 8. Thus, when tabs 41 on beams 37 are passed into apertures 29 of end frame 27 with the spaced apart relation being established therebetween, as previously discussed, an abutment surface 111 on at least one of beams 37 is seated aainst a confronting seating surface 67 therefor on end frame 27 at least generally adjacent the aperture in which the tab on the at least one beam is received. Of course, if bore 35 of stator 33 was not undesirably skewed and if end frame 27 was not undesirably warped, then abutment surface 111 of each beam would be seated against each confronting seating surface 67 therefor on end frame 27 at least generally adjacent aperture 29 therein. In the event one of the opposite side edges of tabs 41 might be abutted against a confronting part of sidewalls 59 of apertures 29 when the tabs are passed into the apertures, stator 33 and beams 37 may be concurrently adjusted or rotated generally about peripheral surface 79 of rotor 47 so as to space apart the opposite side

edges of the tabs from the confronting parts of the aperture sidewalls in end frame 27, as best seen in Figure 7.

After the disposition of tabs 41 and abutment surfaces 111 of beams 37 with respect to apertures 29 and seating surfaces 67 of end frame 27, as discussed above, bore 73a in bearing 71a of lubrication and bearing system 69a on end frame 27a is fitted or otherwise engaged about end portion 45a of shaft 43, as best seen in Figure 9. With bearing bore 73a so received about shaft end portion 45, end frame 27a is moved downwardly so as to pass apertures 29a therein over tabs 41a on opposite end portions 39, 39a of beams 37 with sidewalls 59a of apertures 29a being predeterminately arranged in spaced apart relation from tabs 41a in the same manner as discussed hereinbefore with respect to tabs 41 and apertures 21 in end frame 27. This downward movement of end frame 27a is terminated when abutment surfaces 111a on at least two of beams 37 become seated against confronting seating surfaces 67a on end frame 27a at least generally adjacent apertures 29a in which tabs 41 are received thereby to define a preselected or assembly position of the end frame. Thus, when tabs 41a are received in aperture 29a of end frame 27a, as discussed above, the tabs are predeterminately arranged in spaced apart relation from sidewalls 59a of the apertures, respectively. Again, it may be noted that even if bore 35 of stator 33 is undesirably skewed when disposed about rotor 47 with shim 107 in shimming engagement therebetween and even if end frame 27a is undesirably warped, the predetermined sizing of tabs 41a and apertures 29a to predeterminately establish the spaced apart relation therebetween is effective to accommodate not only undesirable skew of stator bore 35 but also undesirable warpage in end frame 27a. Of course, if bore 35 of stator 33 is not undesirably skewed and if end frame 27a is not undesirably warped, then abutment surfaces 111a of each beam 37 would be seated against each confronting seating surface 67a therefor on end frame 27a at least generally adjacent apertures 29a therein. In the event one of the side edges of tabs 41a might be abutted against a confronting part of sidewalls 59a of apertures 29a when the tabs are received therein, end frame 27a may be adjusted or rotated generally about the engagement of bore 73a of bearing 71a with shaft end portion 45a so as to space apart the opposite side edges of the tabs from the confronting parts of the aperture sidewalls in end frame 27a, respectively.

With end frame 27a arranged in its assembly position, as discussed above, an upper assembly fixture 113 of apparatus 91 may be protractively actuated downwardly toward the end frame in order to bias into engagement therewith a set of resilient means, such as for instance coil springs 115 or the like, carried by the upper assembly fixture. When resilient means or springs 115 are engaged with end frame 27a, the compressive forces of the springs urge the end frame into its assembled position with the spaced apart relation between apertures 29a in the end plate and tabs 41a on beams 37 being maintained, respectively. At this time, locking mechanism 103 may be deactivated so as to interrupt the holding engagement between plunger 105 of the locking mechanism and opposite end portion 45 of shaft 43 received in locating recess 101 of lower assembly fixture 89 which, as previously mentioned, was effective to maintain rotatable assembly 25 in the assembly position thereof against the compressive force of the caged thrust spring 99. Therefore, when the holding force of locking plunger 105 is released from shaft end portion 45, the compressive force of thrust spring 99 is effective to move rotatable assembly upwardly relative to end frames 27, 27a and stator 33 in the assembly positions thereof. Upon this upward movement of rotatable assembly 25 in response to the compressive force of thrust spring 99, rotor 47 is slidably repositioned within stator bore 35 on shims 107 interposed therebetween, and such upward movement is terminated when thrust collar 97a on end portion 45a of shaft 43 becomes biased in engagement with thrust taking surface 75a of bearing 71a in lubrication and bearing system 69a on end frame 27a. In this manner, end play is provided in dynamoelectric machine 21 with thrust spring 99 urging thrust collars 97, 97a into engagement with thrust taking surfaces 75, 75a of bearings 71, 71a, respectively, as discussed above; however, it may be noted that the compressive forces of springs 115 on upper assembly fixture 113 are predeterminately greater than that of thrust spring 99 thereby to insure that end frame 27a is not displaced from its assembly position on beams 37 when the compressive force of the thrust spring is exerted against the end frame through the seating engagement of bearing 71a on bearing seating surface 53a of the end frame.

As illustrated in Figure 9 and as best seen in Figures 11, 13, and 14, a pair of sets of welding means 117, 117a are provided for generally simultaneously welding end frames 27, 27a at least generally adjacent sidewalls 59, 59a of apertures 29, 29a therein to tabs 41, 41a on opposite end portions 39, 39a of beams 37 extending through the apertures, respectively, as best seen in Figures 7 and 8. A pair of sets of welds 119, 119a thus created by the welding means span across at least a part of the space predeterminately established between tabs 41, 41a and aperture sidewalls 59, 59a thereby to interconnect the end frames against displacement from the opposite ends of the beams when the end frames and stator 33 are in the assembly positions thereof, respectively. Welding means 117 are protractively and retractively movable on lower assembly fixture 89 with respect to preselected welding positions therefore, respectively, and welding means 117a are carried by upper assembly fixture 113 so as to be conjointly movable therewith to the preselected welding positions, as discussed in greater detail hereinafter.

Subsequent to the welding of end frames 27, 27a and beams 37, shims 107 are retracted through ventilation openings 55 in end frame 27 and shim passages 109 in location seat 87 of lower assembly fixture 89 so as to be removed from shimming engagement between stator bore 35 and rotor

peripheral surface 79. Thus, upon the retraction of shims 107, it may be noted that the aforementioned generally uniform air gap established by shims 107 between stator bore 35 and rotor peripheral surface 79 is maintained by the welded interconnection of end frames 27, 27a with beams 37 of stator 33 since not only undesirable skew of the stator bore but also undesirable warpage of the end frames is accommodated by this method of assembling dynamoelectric machine 21, as previously discussed. To complete the description of this method of assembling dynamoelectric machine 21, upper assembly fixture 113 is retracted upwardly disengaging its springs 115 from end frame 27a, and the dynamoelectric machine may be removed from apparatus 91 displacing end frame 27 and shaft end portion 45 from location seat 87 and locating recess 101 of lower assembly fixture 89.

With reference again to the drawings in general and recapitulating at least in part with respect to the foregoing, apparatus 91 is provided for securing beams 37 on stationary assembly 23 for dynamoelectric machine 21 to end frames 21, 21a thereof with the beams having tabs 41, 41a on opposite ends 39, 39a thereof and with the end frames having apertures 29, 29a extending therethrough predeterminately sized larger than the tabs, respectively (Figures 1-14). Means such as location seat 87 of lower assembly fixture 87 is provided for locating end frame 27 with opposite end portion 39 of at least one of beams 37 seated thereon and with tabs 41 in apertures 29 of end frame 27 arranged predeterminately in spaced apart relation therefrom, respectively (Figures 2, 7, 8, 11, and 13). Resilient means, such as springs 115 of upper assembly fixture 113, is provided for biasing end frame 27a against opposite end portions 39a of at least two of beams 37 with tabs 41a on opposite end portions 39a of the beams being received in apertures 29a of end frame 27a and arranged predeterminately in spaced apart relation therefrom, respectively (Figures 7-9 and 13). Welding means 117, 117a are provided for generally simultaneously welding tabs 41, 41a to a part of end frames 27, 27a at least generally adjacent apertures 29, 29a when the tabs and the apertures are in the spaced apart relation thereof, respectively (Figures 7-9 and 11-13).

More particularly and with specific reference to Figures 10-13, apparatus 91 comprises a work station having a frame or housing 131 including a base plate or lower cross member 133, an intermediate plate or cross member 135, and a top plate or cross member 137 which are respectively secured to the frame by suitable means, as best seen in Figure 10.

Lower assembly fixture 89 is generally centrally located on intermediate plate 135 of apparatus 91 by suitable means (not shown), and the fixture extends through an opening 139 provided therefor in the intermediate plate, as best seen in Figures 11 and 12. The aforementioned welding means 117 include a set of four plasma needle arc welding torches 141 which are respectively slidably arranged on guide rods or rails 143 secured to intermediate plate 135 generally about lower assembly fixture 89, and the torches are respectively drivenly connected for conjoint reciprocal movement with a respective drive or piston rod 145 of a set of actuating means, such as for instance a servo motor 147 or the like which may be of the double acting air or hydraulic motor type. Thus, upon actuation of servo motors or actuating means 147, torches 141 are protractively movable from a retracted or at rest position on guide rails 143 toward the preselected welding or protractive positions thereof, as shown in dotted outline in Figure 12, adjacent lower assembly fixture 89 to generally conjointly create welds 119 interconnecting end frame 27 with tabs 41 of beams 39, as previously discussed and as illustrated in Figures 7-9. Torches 141 are available from the Linde Division of the Union Carbide Corp., Chicago, Illinois under model number 997450. Although welding means 117 and torches 141 are illustrated herein for purposes of disclosure, it is contemplated that other welding means of various other types may be utilized within the scope of the invention so as to meet at least some of the objects thereof.

Locking mechanism 103 also includes actuating means, such as for instance a servo motor 149 or the like which may be of the double acting air or hydraulic type, and actuating means or servo motor 149 is mounted by suitable means to intermediate plate 135 of apparatus 91 generally adjacent upper assembly fixture 89 thereon, as best seen in Figures 4 and 11. Plunger 105 of locking mechanism 103 is reciprocably slidably movable in a passage means, such as for instance a groove or slot 151 or the like, provided therefor in lower assembly fixture 89 and which intersects or opens into locating sleeve 101 thereof, as best seen in Figures 4 and 11. Locking plunger 105 is drivenly connected for conjoint reciprocal movement with a drive or piston rod 153 of servo motor 149. Thus, upon actuation of servo motor 149, plunger 105 of locking mechanism 105 is protractively and retractively movable between an at rest position, as best seen in Figure 11, and a protracted or actuated position, as best seen in Figure 4. Of course, in its protracted position, locking plunger 105 is engaged in holding relation with shaft end portion 45 of rotatable assembly 25 received within location sleeve 101 of lower fixture assembly, as previously discussed and as best seen in Figure 4.

As best seen in Figures 10-12, another actuating means, such as for instance a servo motor 155 or the like which may be of the double acting air or hydraulic type, is mounted by suitable means to base plate 133 of apparatus 91 and includes a reciprocably movable drive or piston rod 157 which is drivingly connected with means, such as a shim support or guide mechanism 159 for instance, for supporting shims 107. Shim guide mechanism 159 includes a pair of generally concentrically arranged cylinders or sleeves 161, 163 for carrying shims 107 and which are interconnected by suitable means with piston rod 157 of servo motor 155 so as to be conjointly reciprocably movable therewith, respectively. Outer shim carrying sleeve 161 is slidably and guidably received in a bore 165 generally axially or vertically provided therefor through the lower end portion of lower assembly fixture 89, and inner shim carrying sleeve 163 is slidably and guidably received

about a guide rod 167 carried by the lower assembly fixture and extending generally concentrically through the lower assembly fixture bore downwardly therefrom toward base plate 133 of apparatus 91. The lower end portions of shims 107 are received between shim carrying sleeves 161, 163, and the upper end portions of the shims are slidably received in shim passage 109 provided therefor in lower assembly fixture 89. Quick disconnect means, such as for instance a set of latches 169 or the like, are respectively pivotally mounted on outer shim carrying sleeve 161 for positioning engagement with shims 107 so as to facilitate quick release thereof whenever it is necessary to change the shims. Thus, upon actuation of servo motor 155, shim actuating mechanism 159 and shims 107 are conjointly protractively movable upwardly from an at rest or retracted position, as best seen in Figure 12, toward a protracted or actuated position so as to affect the upward movement of shims 107 through shim passages 109 in lower assembly fixture 89 thereby to position the shims about peripheral surface 79 of rotor 47, as previously discussed and best seen in Figures 5 and 12.

Upper assembly fixture 113 includes a carrier plate 171 having a generally central portion 173 secured by suitable means to the lower end of a reciprocably movable drive or piston rod 175 of another actuating means, such as for instance a servo motor 177 or the like which may be of a double acting air or hydraulic type, and actuating means or servo motor 177 is, in turn, secured by suitable means to top cross plate 137 of frame 131 in apparatus 91, as best seen in Figures 10, 13, and 14. A set of arms 179 are integrally provided on carrier plate 171 emanating generally radially from central portion 173 of the carrier plate, and the aforementioned welding means 117a are fixedly mounted by suitable means to the upper side of the carrier plate arms, respectively. Welding means 117a includes another set of four plasma needle arc welding torches 181 which are generally similar to welding torches 141 discussed above, and the nozzles of torches 181 extend through a set of openings 183 provided in preselected locations therefor through central portion 173 of carrier plate 171, respectively. Springs 115 are carried on a set of retainers 185 therefor secured to carrier plate 171 generally adjacent central portion 173 and extending from the lower side thereof, respectively. Thus, upon actuation of actuating means or servo motor 177, upper assembly fixture 113 is protractively movable from a retracted or at rest position thereof, as seen in Figures 10 and 13, downwardly toward lower assembly fixture 89 on cross plate 135 of apparatus 91 into a protracted or actuated position, as best seen in Figure 9. Upon this protractive movement of uppper assembly fixture 113 into the actuated position thereof, springs 115 on the lower side of the upper assembly fixture are biased into engagement with end frame 27a and welding torches are predeterminately positioned to create welds 119a interconnecting end frame 27a with tabs 41a on beams 39, as previously discussed and as illustrated in Figures 7-9.

CLAIMS

1. A method of securing a set of beams of a stationary assembly for a dynamoelectric machine to a pair of opposite end frames thereof, the opposite ends of the beams having respective tabs extending therefrom, and the end frames each having a set of apertures extending therethrough, the apertures being sized predeterminately larger than the tabs, and the method comprising:

locating the tabs at the opposite ends of the beams at least in part within the respective apertures in the end frames and spacing the tabs from the sidewalls of the apertures; and

welding generally simultaneously at least a part of the end frames adjacent the respective apertures to at least a part of each tab located therein.

2. A method according to Claim 1 in which the tabs extend from respective seats provided on the opposite end portions of the beams, and the sidewalls of the apertures intersect opposite faces of the respective end frames, and the method further comprising:

abutting one of the opposite seats of at least one of the beams against one of the opposite faces of one of the end frames;

rotating the beams conjointly with respect to the one end frame and ensuring the spacing apart of the tabs on the one opposite end of the beam from the sidewalls of the apertures in the one end frame;

placing the apertures in the other end frame generally about the respective tabs at the other ends of the respective beams;

abutting the other of the opposite seats of at least two of the beams against one of the opposite faces of the other end frame; and

rotating the other end frame on at least the other opposite seats of the at least two beams and ensuring the spacing apart of the sidewalls of the apertures in the other end frame from the tabs on the other opposite ends of the beams.

3. A method of securing a set of beams mounted on a stator for a dynamoelectric machine to a pair of opposite end frames to ensure the alignment of a bore in the stator about a preselected axis in the event the stator bore is skewed, the beams having a pair of opposite ends with a pair of opposite tabs extending therefrom, respectively, and the end frames each having a set of apertures extending therethrough with sidewalls of the apertures being sized predeterminately larger than the tabs on the opposite ends of the beams, respectively, the method comprising:

locating the tabs on one of the opposite ends of the beams at least in part within the apertures in one of the end frames and canting conjointly the beams and the tabs thereof located within the apertures in the one end frame to compensate for any skewing of the stator bore and effect its alignment about the preselected axis therefor;

adjusting the beams conjointly to ensure the spacing apart of the tabs on the one opposite ends of the beams from the sidewalls of the apertures in the one end frame, respectively, while maintaining the alignment of the stator bore about the preselected

axis;

placing the apertures in the other of the end frames generally about the tabs at the other ends of the beams and adjusting the other end frame to ensure the spacing apart of the sidewalls of the apertures in the other end frame from the respective tabs;

welding the end frames at least generally adjacent the apertures therein to at least a part of each tab arranged within respective ones of the apertures.

4. A method of assembling a dynamoelectric machine having a stationary assembly and a rotatable assembly, the stationary assembly including a pair of opposite end frames with respective sets of apertures extending therethrough, a stator, and a set of beams secured to the stator, the opposite ends of the beams being provided with respective oppositely extending tabs; and the rotatable assembly including a rotor secured to the shaft between opposite end portions thereof, the method comprising:

locating one end frame and the rotatable assembly generally in preselected positions with one of the shaft end portions extending through a generally central opening in the end frame;

aligning a bore of the stator at least in part about the rotor to define an air gap therebetween;

receiving the tabs at one end of the beams within respective apertures of the set in the located end frame;

disposing the apertures of the set in the other end frame generally about the tabs at the other ends of the beams; and

welding the end frames at least generally adjacent the respective aperture sets to at least a part of each tab within the respective apertures.

5. The method as set forth in Claim 4 further comprising engaging the said one end of at least one of the beams with the located end frame when the tabs on the said one ends are received with the respective apertures.

6. The method as set forth in Claim 4 or Claim 5 in which the said other ends of at least two of the beams are engaged with the said other end frame when the tabs on the said other ends of the beams are disposed within their respective apertures.

7. The method as set forth in any one of the Claims 4 to 6 further comprising locking the rotatable assembly in its preselected position.

8. The method as set forth in Claim 7 further comprising unlocking the rotatable assembly and moving it resiliently toward another preselected position with respect to the stator bore and end frames prior to the welding of the frames.

9. The method as set forth in Claim 4 in which the said other end frame is urged in a direction to ensure the abutment thereof with the said other ends of at least two of the beams prior to the welding of the frames.

10. The method as set forth in Claim 4 wherein the apertures are sized predeterminately larger than the respective tabs, and wherein the tabs on the said one ends of the beams are positioned in spaced apart relation with respect to their respective apertures when received therein.

11. The method as set forth in Claim 10 wherein the tabs on the said other ends of the beams are positioned generally in spaced apart relation with respect to their respective apertures when the apertures are disposed thereabout.

12. The method as set forth in Claim 4 wherein the aligning step includes arranging a set of shims generally about the rotor of the rotatable assembly and placing the stator bore about the rotor and the shim set with the shim set being engaged between the rotor and the stator bore so as to define the air gap therebetween.

13. A method of assembling a dynamoelectric machine having a stationary assembly and a rotatable assembly, the stationary assembly including a pair of opposite end frames with a pair of sets of apertures extending therethrough, respectively, at least one of the end frames having a generally central opening spaced from the apertures therein, a stator, a set of beams secured to the stator, and the beams having a pair of opposite ends with a pair of oppositely extending tabs thereon, respectively, and the rotatable assembly including a shaft having a pair of opposite end portions, and a rotor secured to the shaft end portions, the method comprising the steps of:

locating the at least one end frame generally in a preselected position;

arranging the rotatable assembly in a preselected position with respect to the at least one end frame with one of the shaft end portions extending through the central opening of the at least one end frame;

locking the rotatable assembly in its preselected position;

aligning the stator about the rotor to define an air gap therebetween;

disposing the tabs on one of the opposite end portions of the beams at least in part within one of the aperture sets in the at least one end frame, respectively;

abutting the one opposite end portion of at least one of the beams with the at least one end frame;

disposing the other of the aperture sets in the other of the end frames generally about the tabs on the other of the opposite ends of the beams, respectively;

abutting the other opposite ends of at least two of the beams with the other end frame;

exerting a force on the other end frame urging it toward the abutment with the other ends of the at least two beams; and

welding generally simultaneously the end frames at least generally adjacent the aperture sets therein to at least a part of each tab on the opposite ends of the beams disposed in the aperture sets, respectively.

14. The method as set forth in Claim 13 wherein the aperture sets are respectively defined by sidewalls in the end frames with the sidewalls being sized predeterminately larger than the tabs on the opposite ends of the beams and wherein the first disposing step includes positioning the tabs on the one opposite ends of the beams predeterminately in spaced apart relation from the sidewalls of the one aperture set in at least one end frame.

15. The method as set forth in Claim 14 wherein

the second disposing step includes positioning the tabs on the other opposite ends of the beams predeterminately in spaced apart relation from the sidewalls of the other aperture set in the other end frame.

16. The method as set forth in Claim 13 wherein the aligning step includes engaging a set of shims between the rotor and the stator so as to define the air gap therebetween.

17. The method as set forth in Claim 13 comprising the intermediate step of unlocking the rotatable assembly and moving it with respect to the stationary assembly toward another preselected position therein prior to the welding step.

18. A method of assembling a dynamoelectric machine having a stationary assembly including first and second opposite end frames having first and second bearings associated therewith and with first and second thrust surfaces on the first and second bearings, respectively, at least the first end frame having a generally central opening therethrough generally in coaxial alignment with the first bearing, first and second sets of apertures extending generally axially through the first and second end frames, a stator having a generally axial bore therethrough, a set of beams secured to the stator with the beams having first and second opposite ends with first and second tabs extending generally axially from the first and second opposite ends of the beams, respectively, and the dynamoelectric machine also having a rotatable assembly including a shaft having first and second opposite end portions, a rotor secured to the shaft between the first and second shaft end portions, a first thrust collar, a thrust spring, and a second thrust collar secured to the second shaft end portion, the method comprising the steps of:

locating the first end frame generally in a preselected position;

arranging the first thrust collar and the thrust spring on the first shaft end portion with the thrust spring engaged between the first thrust collar and a part of the rotor at least adjacent the first shaft end portion:

inserting the first shaft end portion through the first bearing and the opening in the first end frame;

engaging the first thrust collar on the first shaft end portion with the first thrust surface on the first bearing;

moving the first shaft end portion further through the first bearing and the opening in the first end frame toward a preselected position with respect thereto;

compressing the spring means between the rotor part and the first thrust collar in its engagement with first thrust surface on the first bearing as the first shaft end portion is moved toward its preselected position;

locking the first shaft end portion in its preselected position;

positioning a set of shims generally about the rotor;

arranging the stator bore generally about the rotor and the shim set with the shim set in shimming engagement therebetween;

passing the first tabs on the first opposite ends of the beams at least in part into the first apertures in the first end shield generally upon the arranging of the stator bore about the rotor and shim set;

seating the first opposite end of at least one of the beams against the first end frame upon the passing of the first tabs on the beams at least in part into the first apertures in the first end frame;

adjusting concurrently the stator and beams with respect to the first end frame so as to arrange the first tabs on the beams in spaced apart relation from the first apertures in the first end frame, respectively;

receiving the second shaft extension in the second bearing associated with the second end frame;

passing the second apertures in the second end frame generally about the second tabs on the second opposite ends of the beams, respectively;

seating the second opposite end of at least two of the beams against the second end frame upon the passing of the second apertures thereof about the second tabs on the beams;

adjusting the second end frame with respect to the beams so as to arrange the second apertures in the second end frame in spaced apart relation from the second tabs on the beams, respectively;

loading resiliently the second end frame in a direction toward the second opposite ends of the beams;

unlocking the first shaft end portion;

moving the first and second shaft end portions in the first and second bearings and also the rotor in the stator bore in response to the compressive force of the thrust spring upon the unlocking of the first shaft end portion;

engaging the second thrust collar with the second thrust surface of the second bearing associated with the second end frame upon the occurrence of the second moving step;

welding generally simultaneously the first and second end frames at least generally adjacent each of the first and second apertures therein to at least a part of each of the tabs extending at least in part into the first and second apertures; and

removing the shim set from the shimming engagement thereof between the rotor and the stator bore.

19. A method of assembling a dynamoelectric machine so as to compensate for skew in the event of the occurrence thereof in a bore of a stator for the dynamoelectric machine and so as to compensate for warpage in the event of the occurrence thereof in a pair of end frames for the dynamoelectric machine, the stator also having a set of beams secured thereto with a pair of sets of oppositely extending tabs on opposite ends of the beams, respectively, and the end frames having a pair of sets of apertures extending therethrough with the apertures having sidewalls being predeterminately sized larger than the tabs, respectively, the method comprising the steps of:

locating one of the end frames in an assembly position;

placing one of the tab sets on the beams within one of the aperture sets in the one end frame

predeterminately in spaced apart relation with the sidewalls of the one aperture set obviating interfering engagement therebetween and positioning the axis of the stator bore generally in alignment with a preselected assembly axis with respect to the preselected assembly position of the one end frame thereby to compensate for stator bore skew and warpage in the one end frame in the event of the occurrence thereof when the one end frame is in its assembly position and the stator bore axis is aligned with the preselected assembly axis therefor;

associating the other of the end frames in an assembly position with respect to the stator when the axis thereof is aligned with the preselected assembly axis thereof and placing the sidewalls of the other of the aperture sets in the other end frame predeterminately in spaced apart relation about the other of the tab sets on the beams obviating interfering engagement therebetween so as to compensate for stator bore skew and warpage in the other end frame in the event of the occurrence thereof when the other end frame is in its assembly position and the stator bore axis is aligned with the preselected assembly axis therefor; and

establishing generally simultaneously a pair of sets of welds interconnecting the tab sets with the end frames at least generally adjacent the sidewalls of the aperture sets and spanning across the spaces predeterminately formed therebetween so as to maintain the assembly position of the end frames with respect to the stator with the axis of the stator bore generally coincidental with the preselected assembly axis.

20. Apparatus for assembling a dynamoelectric machine having a stationary assembly and a rotatable assembly, the stationary assembly including a stator having a bore therethrough, a set of beams secured to the stator and having a pair of opposite ends with a pair of oppositely extending tabs thereon, respectively, a pair of opposite end frames having a pair of sets of aperture therethrough with the apertures being sized predeterminately larger than the tabs, respectively, and at least one of the end frames having a generally central opening therethrough, the rotatable assembly including a shaft having a pair of opposite end portions with a rotor secured to the shaft between the opposite end portions thereof, the apparatus comprising:

supporting means for seating the at least one end frame;

means on said supporting means for engagement with at least a part of the at least one end frame to locate it generally in a preselected position on said supporting means;

recess means associated with said supporting means for receiving one of the opposite ends of said shaft with the one opposite end portion of the shaft extending through the generally central opening in the at least one end frame and for aligning the rotatable assembly generally along a preselected axis;

means for locking engagement with the one opposite end portion of the shaft received in said recess means so as to maintain the rotatable assembly aligned generally along the preselected axis therefor;

means for advancing a set of shims generally about the rotor of the rotatable assembly when it is aligned generally along the preselected axis therefor with said shim set being engaged between the rotor and the stator bore to establish a preselected air gap therebetween upon the disposition of the stator bore about said shim set and the rotor with the tabs on one of the opposite ends of the beams extending at least in part into one of the aperture sets in the at least one end frame in spaced apart relation therefrom, respectively;

means for resiliently urging the other of the end frames toward seating engagement with the other of the opposite ends of at least two of the beams when the other of the aperture sets in the other end frame are arranged generally about the other of the tabs in the other opposite ends of the beams in spaced apart relation therewith, respectively, and

a pair of sets of means for generally simultaneously welding at least a part of each tab of the one and other tabs to a part of the one and other end frames at least generally adjacent each aperture of the one and other aperture sets with the tabs and aperture sets in the spaced apart relation thereof, respectively.

21. Apparatus for securing a set of beams on a stationary assembly for a dynamoelectric machine to a pair of opposite end frames thereof, the beams having a pair of sets of tabs on opposite end portions thereof, respectively, and the end frame having a pair of sets of apertures extending therethrough predeterminately larger than the tabs, respectively, the apparatus comprising:

means for locating one of the end frames with one of the opposite ends of at least one of the beams being seated thereon and with one of the tabs on the one opposite ends of the beams being received in one of the aperture sets of the one end frame in spaced apart relation therefrom, respectively;

means for biasing the other of the end frames against the other of the opposite ends of at least two of the beams with the other of the tabs on the other opposite ends of the beams being received in the other of the aperture sets in the other end frame in spaced apart relation therefrom, respectively; and

means for generally simultaneously welding at least a part of each of the one and other tabs to a part of the one and other end frames at least generally adjacent each aperture of the one and other aperture sets when the tabs and the aperture sets are in the spaced apart relation thereof, respectively.

22. The apparatus as set forth in claim 21 wherein said locating means includes a seat on which the one end frame is oriented.

23. The apparatus as set forth in claim 21 wherein said locating means includes means for association with a part of the one end frame to insure preselected orientation of the one end frame on said locating means.

24. The apparatus as set forth in claim 21 further comprising a pair of assembly fixtures respectively including said locating means and said biasing means and with one of said assembly fixtures being movable with respect to the other thereof.

25. The apparatus as set forth in claim 24 wherein said welding means comprises a pair of sets of welding torches, one of said welding torch set being mounted on said one assembly fixture so as to be conjointly movable therewith and the other of said welding torch set being movably mounted on the apparatus adjacent the other of said assembly fixture.

26. Apparatus for assembling a dynamoelectric machine having a stationary assembly and a rotatable assembly, the stationary assembly including a stator having a bore, a set of beams secured to the stator with a pair of sets of oppositely extending tabs on opposite ends of the beams, respectively, a pair of opposite end frames having a pair of sets of apertures therethrough with the apertures being predeterminately sized larger than the tabs, respectively, and at least one of the end frames having a generally central opening therethrough, the rotatable assembly including a shaft having a pair of opposite end portions with a rotor secured to the shaft between the opposite end portions thereof, the apparatus comprising:

a pair of relatively movable assembly fixtures;

seating means on one of said assembly fixtures for supporting the at least one end frame in an assembly position thereon;

recess means in said one assembly fixture for receiving one of the shaft end portions with the one shaft end portion extending through the generally central opening of the at least one end frame;

means for establishing a preselected air gap between the stator bore and the rotor when the one shaft end portion is received in said recess means upon the disposition of the stator about the rotor with one of the tab sets of the beams predeterminately positioned within and in spaced apart relation from one of the aperture sets in the at least one end frame, respectively;

resilient means on the other of said assembly fixture for biasing engagement with the other of the end frames with the other of the aperture sets thereof receiving in spaced apart relation the other of the tab sets of the beams;

motor means associated with the other assembly fixture for actuating it toward the one assembly fixture to affect the biasing engagement of the resilient means with the other end frame;

a pair of sets of means movable toward welding preselected positions for generally simultaneously welding the end frames with the tab sets in the spaced apart relation thereof within the aperture sets of the end frames, respectively, one of said welding means sets being mounted to said other assembly fixture so as to be conjointly movable toward the preselected welding positions thereof when the other assembly fixture is actuated by said motor means; and

a set of means associated with the other of said welding means set for actuating the other welding means set toward the welding position thereof.

27. The apparatus as set forth in Claim 26 wherein said air gap establishing means includes a set of shim means for shimming engagement between the stator bore and rotor.

28. The apparatus as set forth in Claim 27 wherein said air gap establishing means further includes means for advancing said shim means set to a position about the rotor prior to the disposition of the stator bore about the rotor.

29. The apparatus as set forth in Claim 28 wherein said one assembly fixture includes a set of passage means extending therethrough for guiding engagement with said shim means set, respectively.

30. The apparatus as set forth in Claim 26 further comprising means associated with said recess means of said one assembly fixture and operable generally for locking engagement with the one shaft end portion received in said recess means.

31. A dynamoelectric machine comprising:

at least one end frame having a pair of opposite faces;

at least one aperture in said at least one end frame with said at least one aperture having a sidewall intersecting with said opposite faces of said at least one end frame;

at least one beam supporting said at least one end frame in the dynamoelectric machine and including at least one abutment surface disposed in abutting engagement with one of said opposite faces of said at least one end frame at least adjacent the intersection of said sidewall of said at least one aperture with said one opposite face of said at least one end frame, a tab integral with said at least one abutment surface of said at least one beam and extending generally axially therefrom at least in part through said at least one aperture in said at least one end, a free end on said at least one tab and spaced adjacent the other of said opposite faces of said at least one end frame, said at least one tab being sized predeterminately smaller than said at least one aperture thereby to predeterminately define a space between said sidewall of said at least one aperture and said at least one tab; and

weld means spanning across the space between said sidewall and said at least one tab for interconnecting said at least one end frame at least adjacent the intersection of said sidewall of said at least one aperture and said other face of said at least one end frame with at least said free end of said at least one tab thereby to predeterminately maintain the space between said at least one tab and said sidewall of said at least one aperture.

32. A dynamoelectric machine comprising:

a pair of opposite end frames each having a set of apertures extending therethrough;

a set of beams each with opposite end portions having respective tabs extending at least in part through corresponding apertures in the respective end frames, the tabs being sized predeterminately smaller than the apertures and being predeterminately arranged in spaced apart relation with the apertures; and

each end frame being interconnected by respective sets of welds adjacent the apertures with at least a part of each of the tabs.

33. A dynamoelectric machine according to Claim 32 wherein the opposite end portions of the beams include respective abutment surfaces, one of the abutment surfaces of at least one of the beams

abutting one of the end frames and the opposite abutment surfaces of at least two of the beams abutting the other end frame.

34. A dynamoelectric machine according to Claim 32 or Claim 33 wherein each aperture includes a sidewall extending through the respective end frame, the sidewalls being in spaced apart relation with the respective tabs received in the apertures.

35. A dynamoelectric machine according to any one of the Claims 32 to 34 wherein the respective welds span across the spaces between the tabs and the respective apertures to effect the interconnection of the end frames with the tabs.

36. A dynamoelectric machine according to any one of the Claims 32 to 35 further comprising a stator disposed between the end frames, the beams being secured to the stator.

37. A dynamoelectric machine according to Claim 36 further comprising a rotatable assembly associated with the stator, each end frame having bearing means for journalling the rotatable assembly.

38. A dynamoelectric machine comprising:

a pair of opposite end frames;

a pair of sets of apertures extending generally axially through said end frames, respectively;

a stator having a generally axial bore extending therethrough and disposed between said end frames;

winding means associated with said stator and extending generally about said bore;

a set of beams secured to said stator including a pair of opposite end portions, respectively, one of said opposite end portions of at least one of said beams being seated against one of said end frames and the other of said opposite end portions of at least two of said beams being seated against the other of said end frames, and a pair of sets of generally axially and oppositely disposed tabs on said opposite end portions of said beams and extending at least in part through said aperture sets in said end frames and predeterminately arranged in spaced apart relation therefrom, respectively;

a pair of sets of welds interconnecting said end frames at least adjacent said apertures therein with at least a part of each of said tabs extending at least in part through said apertures to maintain the spaced apart relation therebetween, respectively;

a rotor disposed at least in part within said bore of said stator;

a shaft secured to said rotor; and

a pair of bearing means associated with said end frames for journalling said shaft, respectively.

39. A dynamoelectric machine comprising:

first and second opposite end frames each having a circumferential portion and a generally central portion;

an opening through said central portion of at least one of said first and second end frames;

first and second sets of apertures located in preselected locations generally adjacent the circumferential portions of said first and second end frames, respectively, and said apertures respectively including sidewalls extending generally axially through said first and second end frames;

a stator disposed generally in axially spaced relation between said end frames and including a generally axial bore therethrough, and a plurality of winding receiving slots arranged generally about said bore;

winding means received in said slots of said stator and extending generally about said bore thereof;

a set of beams secured to said stator and including first and second opposite abutment surfaces, respectively, said first abutment surface of at least one of said beams being disposed in abutting engagement with said first end frame and said second opposite abutment surface of at least two of said beams being disposed in abutting engagement with said second end frame, first and second sets of opposite tabs integrally formed on said first and second opposite abutment surfaces of said beams and extending generally axially therefrom at least in part through said first and second apertures in said first and second end frames, said tabs being sized predeterminately smaller than said apertures and predeterminately arranged generally in radially spaced apart relation from said sidewalls of said apertures, respectively;

first and second sets of welds interconnecting said first and second end frames at least adjacent said sidewalls of said first and second apertures therein with at least a part of each tab of said first and second tabs extending at least in part through said first and second apertures in the radially spaced apart relation with the sidewalls thereof, respectively;

a rotatable assembly including a shaft having first and second opposite shaft extensions, and a rotor disposed at least in part within said bore of said stator and secured to said shaft between said first and second shaft extensions; and

first and second bearing means associated with said first and second end frames generally adjacent said central portions thereof for journalling said first and second shaft extensions, respectively, one of said first and second bearing means extending generally about said opening through said central portion of said at least one of said first and second end shields with one of said first and second shaft extensions extending generally axially through said opening.

40. A method of assembling a dynamoelectric machine substantially as herein described with reference to the accompanying drawings.

41. A dynamoelectric machine substantially as herein described with reference to the accompanying drawings.

42. Apparatus for assembling a dynamoelectric machine substantially as herein described with reference to the accompanying drawings.

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